BARBEN
Analyzer Technology, LLC

Instruction Manual
Natural Gas Measurement

4401 Oxy-Trace v4

Fiber-optic trace oxygen meter

Manual Revision 1

Instruction Manual
4401 Oxy-trace v4
Natural Gas

PC Software Version 4401TRACEv1.14
October 2006

Specification:

Stand-alone one-channel fiber-optic oxygen meter with graphical LCD and Data-logger for oxygen mini-sensors.

PC control of the oxygen meter is available.

Excitation wavelength of 505 nm.

Polymer optical fibers (POF) of 2 mm diameter connected by SMA fiber connectors.

Manufacturer:

Barben Analyzers Technology L.L.C.
5200 Convair Drive
Carson City, Nevada 89706
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Table of Contents Page

1. Preface…….. 4
2. Safety Guidelines of the 4401 Oxy-NG…… 5
3. Description of the 4401 Oxy-trace NG Device…… 7
4. General Instructions…… 8
5. Service…….. 8
6. Terminal Board Layout……... 9
7. Required Basic Equipment……11
8. Optical Oxygen Sensors……12
9. Housing for Oxygen in Natural Gas……..13
10. Configuration for the 4401……..15
    - 10.1 Applying Power to the 4401…….. 15
    - 10.2 Sensor Selection……17
    - 10.3 Setting the Measurement Parameters……17
    - 10.4 Data Logging……..19
    - 10.5 Configuration Menu……...20
        - 10.5.1 Analog Output……20
        - 10.5.2 Analog Input……...21
        - 10.5.3 Clock/Date Adjustment……22
        - 10.5.4 Display Illumination……...22
        - 10.5.5 Resetting the Configuration……22
    - 10.6 Diagnostics and Test…… 22

11.0 Calibration……22
    - 11.1 Calibration…….. 22
    - 11.2 Calibration of the BOS 3 w/Temperature Compensation…… 23
    - 11.3 Calibration of the BOS 3 without Temperature Compensation……...23
    - 11.4 Calibration of the BOS 3 with Manual Temperature Compensation……...24

12.0 Software Description…… 24
    - 12.1 Software Installation…….. 24
    - 12.2 Function and Description…….. 25
        - 12.2.1 Menu Bar…… 26
        - 12.2.2 Display…… 27
        - 12.2.3 Instrument Information…….. 28
    - 12.3 LED Intensity……29
    - 12.4 Oxygen Units……31
    - 12.5 Analog Output…….. 31
    - 12.6 Analog Input……..31
    - 12.7 Control Bar…… 32
        - 12.7.1 Control Buttons…… 33
        - 12.7.2 Temperature Compensation…….. 35
        - 12.7.3 External Temperature Compensation…….. 35
        - 12.7.4 Data Downloading……36
        - 12.7.5 Warning Lights……..37
        - 12.7.6 Graphic Display…… 37

13.0 Error Codes…… 38
    - 13.1 Saved Data Handling……...38
    - 13.2 Advice for Correct Measurements…… 40
    - 13.3 Signal Drifts Due to Oxygen Gradients…… 40
    - 13.4 Signal Drifts Due to Temperature Gradients…… 40
    - 13.5 Signal Drifts Due to Photo-Decomposition…….. 40
    - 13.6 Signal Drifts Due to Too Much Light…….. 40
    - 13.7 Performance Verification…… 41

13.8 Correction for Air Pressure……..41
14.0 Technical Data……42
14.1 General Data……..43
15.0 Technical Notes……44
16.0 Enclosure Drawing……...45
17.0 Parts List……46
18.0 Trouble Shooting……..46
19.0 Error Codes……...47

1.0) Preface

Congratulations!

You have chosen the new innovative technology for measuring oxygen concentration in natural gas from Barben Analyzer Technology!

The 4401 Oxy-trace-NG for Natural Gas measurements is a fixed instrument easy to use, stand-alone fiber optic oxygen meter. The data evaluation is PC supported.

The 4401 Oxy-trace-NG was specially developed for small fiber optic oxygen sensors in a flow through ¼" Swagelok tee and integrated sensor. It is based on a fluorescence quenching technology, which creates very stable, internally referenced measured values. This enables a more flexible use of oxygen sensors in a variety of sensor fittings, if required.

Optical oxygen sensors (also called optodes) have the following outstanding properties:

- They are small
- They do not consume oxygen
- Limit of detection is 0.5 ppm oxygen
- Three (3) different measurement ranges
- On-line **non-invasive** and **non-destructive** oxygen measurements
- The 4401-NG can measure in other gas phase ranges using different Optodes (BOS 1, BOS2)
- They have excellent long term stability

Therefore, our sensors are ideally suited for measuring in every range of gas phase concentration in Natural Gas in a variety of fittings, i.e., 12 mm, ½" NPT, or ¾" NPT.

Please feel free to contact our service team to find the best solution for your application.

Thank you.

Barben Analyzer Technology

2.0) Safety Guidelines

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE WORKING WITH THIS INSTRUMENT!

This device has left our factory after careful testing of all functions and safety requirements.

The perfectly functioning and operational safety of this instrument can only be ensured if the user observes the usual safety precautions as well as the specific safety guidelines stated in this operating manual.

- Before connecting the device to the electrical supply network, please ensure that the operating voltage stated on the power supply corresponds to the main voltage input as describe on page 8.
- The perfect functioning and operational safety of the instrument can only be maintained under the environmental conditions, as specified, in Chapter 10 "Technical Data" of this operating manual.
- If the instrument is moved from cold to warm surroundings, condensation may form and interfere with the functioning of the instrument. In this event, wait until the temperature of the instrument reaches room temperature before putting the instrument back into operation.
- Calibration, maintenance and repair work must only be done by a suitable qualified technician, trained by Barben Analyzer Technology L.L.C.
- Especially in the case of any damage to current-carrying parts, such as the power supply cable or the power supply itself, the device must be taken out of operation and protected against being put back into operation.
- If there is any reason to assume that the instrument can no longer be operated without a risk, it must be set aside and appropriately marked to prevent further use.
- The safety of the user may be endangered, e. g., if the instrument

* is visibly damaged;
    * no longer operates as specified;
    * has been stored under adverse conditions for a lengthy period of time;
    * has been damaged in transport

- If you are in doubt, the instrument should be sent back to the manufacturer, Barben Analyzer Technology, for repair and maintenance.
- The operator of this measuring instrument must ensure that the following laws and guidelines are observed when using dangerous substances:
    * National protective labor legislation;
    * Safety regulations for accident prevention;
    * Safety data-sheets of the chemical manufacturer

The 4401 Oxy-trace v4 is enclosed in a NEMA 4 Stainless Steel enclosure;
The 4401 Oxy-trace v4 can be used in either industrial or laboratory environment;
The 4401 Oxy-trace v4 is Class I, Division II, Groups. A, B, C, and D (FM/CSA);

We explicitly draw your attention to the fact that any damage to the instrument by misuse will void any guarantee warranties.

Any internal operations on the unit must be done by a qualified technician that has been trained and authorized by Barben Analyzer Technology and under antistatic conditions.

The 4401 Oxy-trace-NG may only be operated by qualified personal.
This measuring instrument was developed for use in the natural gas industry. Thus, we must assume that, as a result of their professional training and experience, the operators will know the necessary safety precautions to take when handling this equipment and use of any cleaning chemicals.

Keep the 4401 Oxy-trace-NG and the equipment such as PT 1000 temperature sensor, power supply and optical sensors out of the reach of children!

As the manufacturer of the 4401 Oxy-trace -NG, we only consider ourselves responsible for safety and performance of the device if

- The device is strictly used according to this instruction manual and the safety guidelines set forth
- The electrical installation of this oxygen measuring instrument corresponds to the standards set forth by (FM/CSA) for hazardous locations in Class I, Division II, Groups A, B, C, and D environments.

"Warning"

The 4401OXY Transmitter assembly is not for use in atmospheres containing an oxygen concentration greater than 21% by volume.

3.0 Description of the 4401 Oxy-trace NG v4 Device

The **4401 Oxy-trace NG** is a precision, ***temperature compensated***, ***stand-alone*** oxygen meter enclosed in a NEMA 4 stainless steel case, designed for use with the BOS family of fiber-optic oxygen sensors in the gas phase and dissolved oxygen measurements.

The rugged design and low power consumption makes the 4401 Oxy ready for indoor and **outdoor** application in Class I, Division II, Groups A – D environments.

4401 Oxy-trace v4 instrument features:

- Fiber-optic oxygen meter with temperature compensation
- Programmable sampling rate
- 128x64 pixel graphical LCD
- 2 x 12bit, programmable voltage outputs with galvanic isolation
- 2 x 12bit, programmable current outputs with galvanic isolation
- 2 x 12bit, programmable analog voltage inputs with galvanic isolation
- measuring range 0 – 250 % air saturation
- 110/220 Vac or 12/24 Vdc Power
- RS 232 interface for PC communication, if desired
- Stainless Steel NEMA 4
- FM/CSA Class I, Division II, Groups A – D approved

The 4401 Oxy-trace NG is a precision oxygen meter, designed for 3 types of sensor ranges; BOS 1 (1 ppb to 1.8 mg/l DO/20 ppm to 4.2% v/v); BOS 2 (20 ppb to 22 ppm DO/50 ppm to 50% v/v); BOS 3 (0.5 ppm to 1000 ppm Gas Phase). The 4401 Oxy-NG is specifically designed for natural gas measurements using a flow through fiber-optic oxygen sensor mounted in a ¼" Swagelok Tee. It is equipped with four independent Analog Outputs (0 – 10 Vdc/4 – 20 mA) and two Analog Inputs. It is a stand-alone instrument with LCD and integrated data-logger. The analog outputs are programmable to provide outputs for oxygen, temperature, phase angle or signal amplitude. The digital interface (RS232) and PC software (included) is used for data storage and external data logging that can store up to 26,000 data samples. Complete control including all calibration and adjustments can be completed through your PC.

4.0 General Instructions:

Warm-Up Time

The warm up time of the electronic and opto-electronic components of the 4401 Oxy-trace NG is 5 minutes. Once the 4401 has warmed up stable measuring values will be obtained.

Maintenance

The instrument is maintenance-free. The housing should be cleaned only with a moist cloth. Never use benzene, acetone, alcohol or other organic solvents. The SMA-fiber connector of the sensor can be cleaned only with lint-free cloth. The sensor tip may be rinsed only with distilled water or ethanol.

Error codes

The error value is binary coded. It means each bit corresponds to one specific error or warning. The summary of error bits is given below:

bit 0 = ADC overflow
bit 1 = Ambient light
bit 2 = no oxygen sensor
bit 3 = no temperature sensor
bit 4 = current output 1 open loop error
bit 5 = current output 2 open loop error
bit 6 = overheat
bit 7 = system restart

Decoding example

If Error value received from a device is **10** then a following error has occurred:

Decimal **10** = Binary **00001010** (Table 1)

Here bit1 ⇔ ambient light and bit3 ⇔ no temperature sensor are “1”. This error code would appear if there was too much of ambient light (sun light illuminating the sensor) and the temperature sensor PT1000 is not connected to the device.

Table 1

0001 = 1	0110 = 6	1011 = 11
0010 = 2	0111 = 7	1100 = 12
0011 = 3	1000 = 8	1101 = 13
0100 = 4	1001 = 9	1110 = 14
0101 = 5	**1010 = 10**	1111 = 15

Binary Numbers

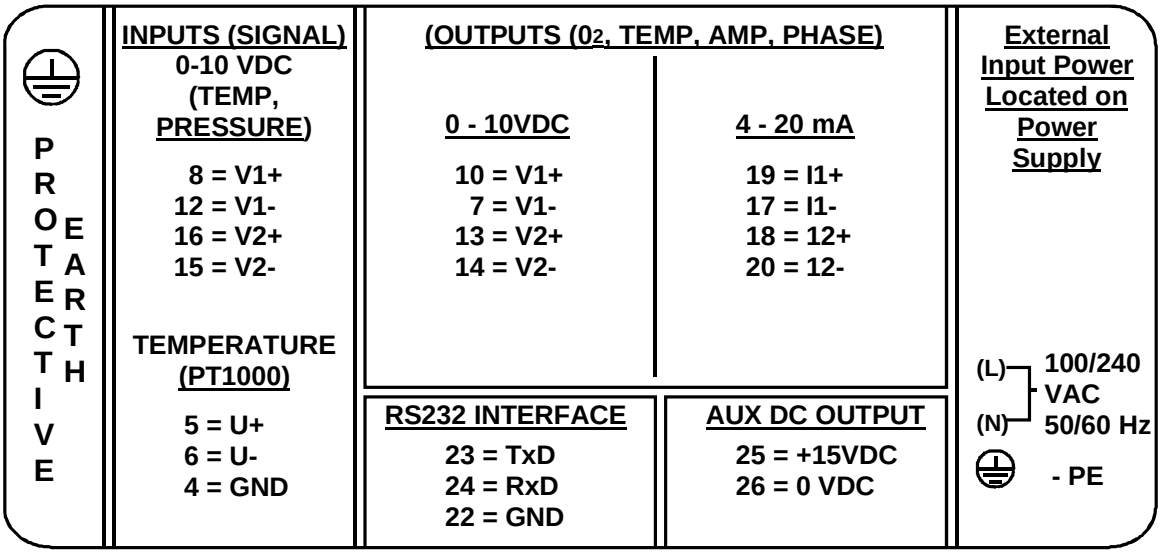
5.0 Service

Maintenance and repair work may only be carried out by the manufacturer:

Barben Analyzer Technology LLC
5200 Convair Drive
Carson City, Nevada 89706
Phone: (775) 883-2500
Fax: (775) 297-4740

6.0 Terminal Layout and Description

Terminal Pin Connection	DESCRIPTION	FUNCTION
SMA Connector	SMA fiber connector	Connect the fiber optic oxygen cable to SMA connector located on the bottom of the 4401.
Wire to Power Supply	Line adapter for power supply	110/220 Vac power supply or optional 24 Vdc powered. (note; must be ordered as 24 Vdc)
Ground (4) Positive (5) Negative (6)	Connector for PT 1000 temperature sensor	Connect the PT 1000 temperature sensor for temperature compensated measurements here.
TxD (23) RxD(24) Gnd (22)	RS232 interface	Connect the device with a RS232 data cable to your PC/Notebook here (optional).
Ch 1 +10/-7 Ch 2 +13/-14	Analog out/input (channel 1/2)	Voltage Output (0-10 V) from terminal board to external recording device or DCS system
Ch 1 +19/-17 Ch 2 +18/-20	Analog out (channel 1/2)	Current Output (4-20 mA) from terminal board to external recording device or DCS system. Note that this is a powered output



Wiring Label 1 (VAC Version)

PROTECTIVE EARTH

INPUTS (VARIOUS)

POWER (9 - 24 VDC)

1 = +VDC
2 = -VDC

TEMPERATURE (PT1000)

5 = U+
6 = U-
4 = GND

0-10 VDC (TEMP, PRESSURE)

8 = V1+
12 = V1-
16 = V2+
15 = V2-

(OUTPUTS (0_2, TEMP, AMP, PHASE)

0 - 10VDC

10 = V1+
7 = V1-
13 = V2+
14 = V2-

4 - 20 mA

19 = I1+
17 = I1-
18 = 12+
20 = 12-

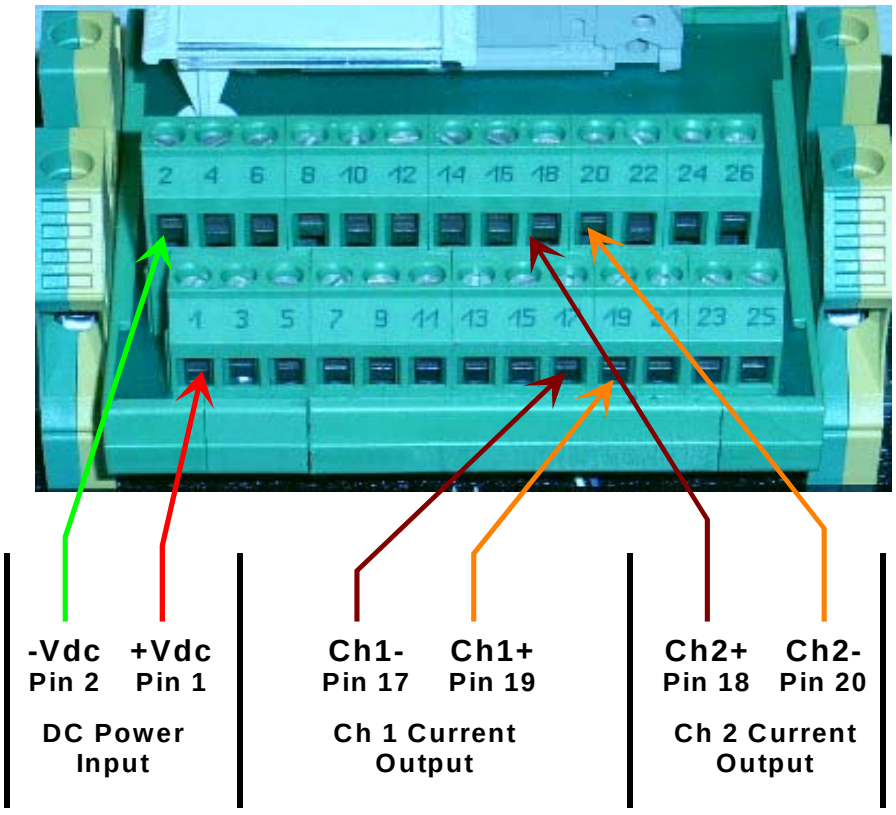
RS232 INTERFACE

23 = TxD
24 = RxD
22 = GND

AUX DC OUTPUT

25 = +15VDC
26 = 0 VDC

Wiring Label 2 (DC Version)


2 4 6 8 10 12 14 16 18 20 22 24 26
1 3 5 7 9 11 13 15 17 19 21 23 25
-Vdc Pin 2
+Vdc Pin 1
DC Power Input
Ch1- Pin 17
Ch1+ Pin 19
Ch 1 Current Output
Ch2+ Pin 18
Ch2- Pin 20
Ch 2 Current Output

Note: Current Sinking Outputs

Terminal Board Connections

7.0 Required Basic Equipment

- Oxygen meter 4401 Oxy-trace NG
- Line adapter (110/220 Vac, Optional 12/24 Vdc)
- Temperature sensor Pt 1000
- Flow through Tee fitting with sensor (DP-BOS3-L5-ST5-NOP-SSJ)
- PC / Notebook (optional)
  (System requirements: Windows 98/2000/XP//Millenium/NT 4.0; Pentium processor, at least 133 MHz, 16 MB RAM)
- RS 232 Cable (optional)

Specifications

INSTRUMENT 4401 Oxy-trace NG (BOS3 Oxygen Sensor for Natural Gas)			
Channels	1 x optical channel (SMA connector) , designed for mini-sensors 1 x PT1000 connector		
Temperature (PT1000)	**Range**	**Resolution**	**Accuracy**
	0-50°C	±0.2°C	±1°C
Digital interface	RS 232 interface with galvanic isolation (19200 Baud, Data-bits 8), (Tinned leads to SUB-D 9 cable for RS232 PC)		
Analog outputs	four independent, programmable 12bit analog I/O channels with galvanic isolation (2 x voltage output 0-10 V; 2 x current output 4-20 mA)		
Analog inputs	four independent, programmable 12bit analog I/O channels with galvanic isolation (2 x voltage input 0-10 V; 2 x current input 4-20 mA)		
Specification	**Range**	**Resolution**	**Accuracy**
Analog output (Oxygen)	Adjustable (0 – 1000)	X.XX < 10/XXXX.X FS	± 5% of Reading
Analog output (Temperature, PT1000)	0-50°C	±0.5°C	±1.5°C
Sample Rate	Programmable (default 3 second)		
Power supply	24 VDC/max.830 mA (110-240 VAC, 50/60 Hz adapter)		
SOFTWARE OxyView			
Oxygen units	**User selectable from**: air-saturation, oxygen-saturation, hPa, Torr, mg/L (=ppm), µmol		
Compatibility	Windows 95/98/2000/Millenium/NT4.0/2000/XP		
Calibration	Conventional two-point calibration in oxygen-free environment (nitrogen) and a second calibration value of 100 ppm (300 ppm Maximum).		
ENVIRONMENTAL CONDITIONS			
Operating Temperature (°C)	0 to +50		
Storage Temperature (°C)	-10 to +65		
Relative humidity (%)	up to 95 (IP 64)		
Dimensions, DxWxH (mm)	8” x 10” x 8”		
Weight (kg)	2.2		
Trace Oxygen Sensor Type BOS3			
	Gaseous Oxygen		
Measurement range	0 – 100 ppm Nominal (Maximum Range 1000 ppm)		
Limit of Detection (LOD)	0.5 ppm		
Resolution	< 10 ppm X.XX; >10 ppm XXXX.X ppm		
Accuracy (20 °C)	5% of the oxygen concentration		

8.0 Optical Oxygen Sensors

Sensor Characteristic of Oxygen-Sensitive Sensors

The operation principle of the optical oxygen sensor is based on the fluorescence quenching of luminescence caused by a collision between molecular oxygen and lumine scent dye molecules in the excited state. Figure 5.1 shows a typical response curve of the BOS 3 oxy gen-sensitive sensor. In the presence of oxygen the signal - in our case the phase angle Φ - decreases.

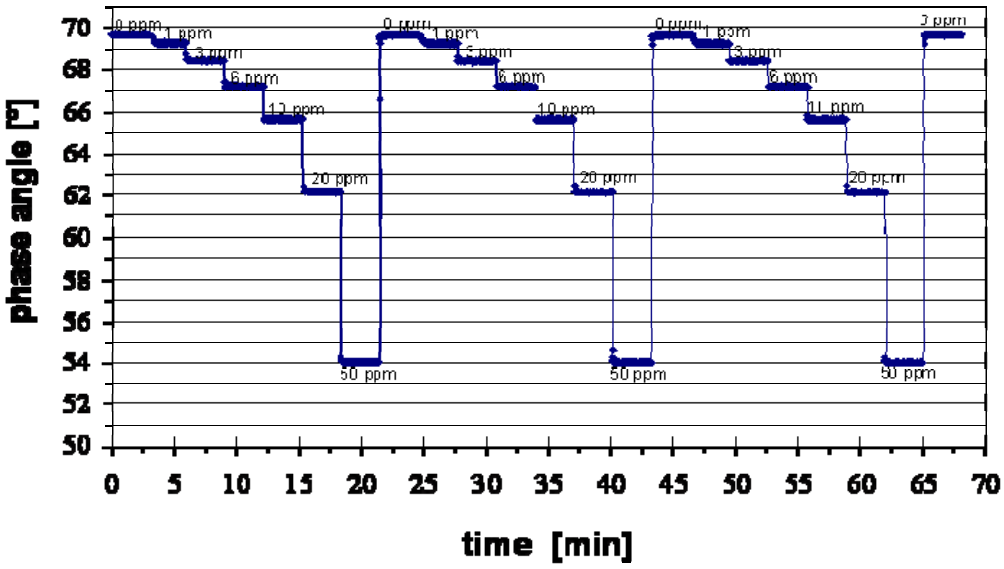


Figure 5.1 Response of the **BOS3** sensor toward changes in the oxygen concentration.

Temperature

Barben Analyzer Technology Optical oxygen sensors must be used with a PT1000 temperature sensor in the temperature range between -10 to 50 °C. Barben Analyzer supplies the PT1000 temperature sensor with each 4401 Oxy-trace NG for compensation and to record temperature variations which are compensated using the 4401 Oxy-trace software.

Cross sensitivity

There exists **no** cross sensitivity for ***carbon dioxide*** (CO_2), ***hydrogen sulfide*** (H_2S), ***sulfur dioxide*** (SO_2)***, pH***, any ionic species like ***sulfide*** (S_2^-), ***sulfate*** (SO_4^{2-}), ***chloride*** (Cl^-) or ***salinity***. Turbidity and changes in the flow rate (DO) have little or no influence on the measurement.

The sensors can also be used in ***methanol***- and ***ethanol-water*** mixtures as well as in ***pure methanol*** and ***ethanol***.

We recommend avoiding other organic solvents, such as acetone, chloroform or methylene chloride, which may swell the sensor matrix rendering it unusable.

Response time

The response time to t_{90} (90% of full scale) in the gas phase for the BOS 3 oxygen sensor is less than 8 seconds.

Optical isolation (Optional)

Optical isolated sensor tips are required in areas where the sensor is not placed in a flow-through fitting, if your sample shows intrinsic fluorescence between 540 - 700 nm. Using optical isolated sensors exclude the impact of colored samples and ambient light on meas urements. Furthermore, the optical isolation layer is applied to eliminate strong ambient light, to improve chemical resi stance especially against oily samples as well as to reduce bio-fouling on the sensor membrane.

Barben Analyzer offers additional optical isolation for all types of oxygen sensors.

Sensor Stability

The oxygen-sensitive membrane can withstand gamma-sterilization, sterilization by ethylene oxide, steam autoclaving (140 °C, 1.5 atm), CIP conditions (cleaning-in-place, 5% NaOH, 90°C), as well as a 3% H_2O_2 (Hydrogen Peroxide) solution if this is required for inline cleaning.

The oxygen-sensitive material may be subject to photo-decomposition resultin g in a sign al drift. Photo-decomposition takes place only du ring illumination of the sensor tip and depends on the intensity of the excitation light.

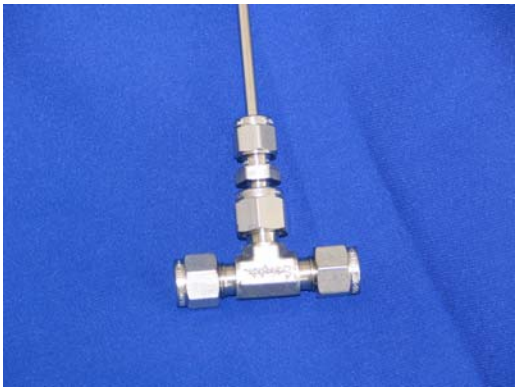
Sensor Drift at 0 % air-saturation (0 ppb) recording 3600, 50000 and 100000 data points.

	Drift per 3600 points	Drift per 50000 points	Drift per 100000 points
BOS2	< 0.15 % air-sat.	< 0.15 % air-sat.	< 0.25 % air-sat.
BOS1	< 1 ppb	< 2 ppb	< 3 ppb

The sensor should b e shielded from ambient light to obta in reliable data. A black overcoat, called optical isolation is strongly recommended to reduce ambient light.

9.0 Housing for Oxygen in Natural Gas (DP-BOS3-L5-ST5-NOP)

Barben Analyzer fiber-optic oxygen sensors are based on 2 mm polymer optical fibers (POF). Depending on the respective application, Barben Analyzer offers a set of different standard fitting designs.

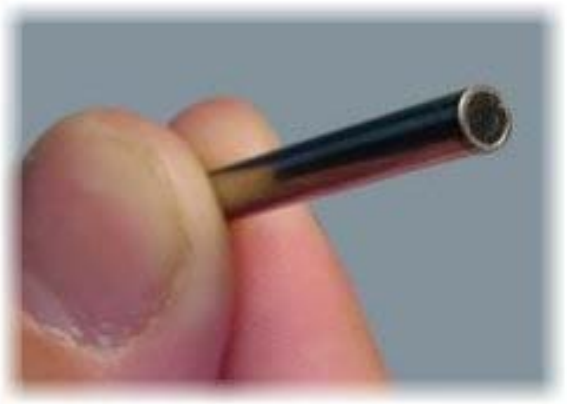


¼" Swagelok "Tee" Flow-Through Fitting

2 mm oxygen dipping probe mounts in the Swagelok "Tee"

Of course, it is possible to build ***customer-specific*** designs. Please feel free to contact our service team to find the best solution for your application.

Trace Oxygen DP Probe

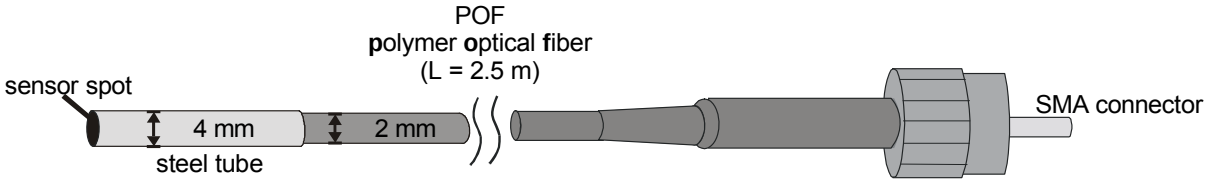


This oxygen sensor consists of a polymer optical fiber (POF) with a polished distal tip which is coated with a planar oxygen-sensitive foil.

The end of the polymer optical fiber is covered with a high-grade steel tube, to protect both the sensor material and the POF.

Usually, the fiber is coated with an optical isolated sensor material in order to exclude ambient light from the fiber tip.

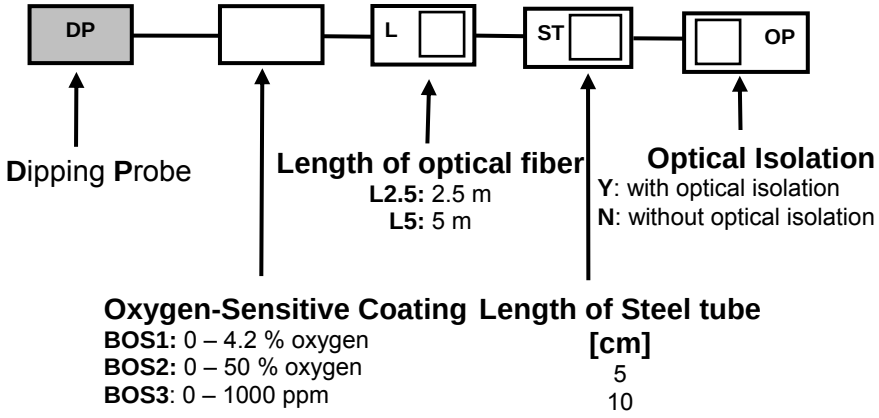
Schematic drawing



Features

- usable for process application
- very rugged sensor with an excellent long-term stability (more than 100000 data points without drift)
- sterilizable (H_2O_2, ethanol, ethylene oxide)
- not autoclavable (POF does not stand autoclaving conditions (140 °C, 1.5 atm))

Ordering information



Example

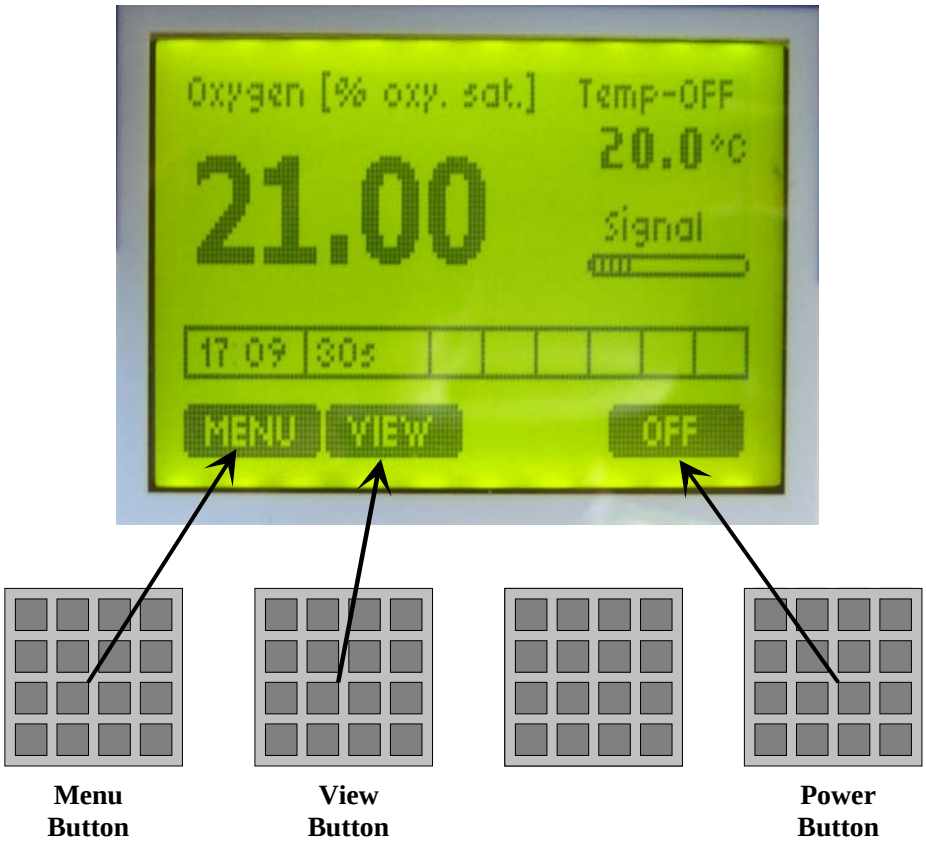
DP–BOS1-L2.5-ST10-YOP you will order a dipping probe (**DP**) coated with an optical isolated (**YOP**) trace oxygen sensor coating type **BOS1** (4 % oxygen). The standard cable length is 2.5 m (**L2.5**), the maximum length is 25 m. The length of the protection steel tube is 10 cm (**ST10**).

10.0 Configuration of the 4401 Oxy-trace v4

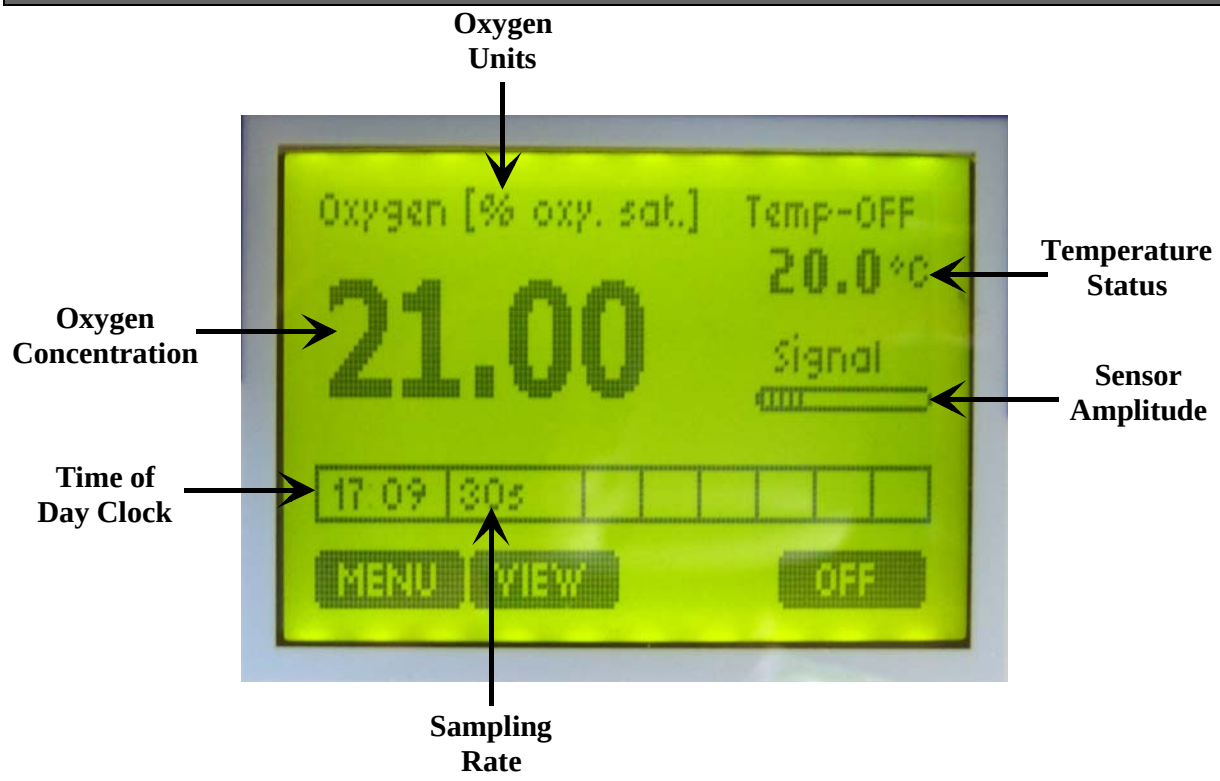
10.1 Powering up the Instrument

Prior to powering up the 4401 Oxy refer to Diagram 1 (Page 8) for the connects for the power supply, temperature sensor and oxygen sensor to the instrument.

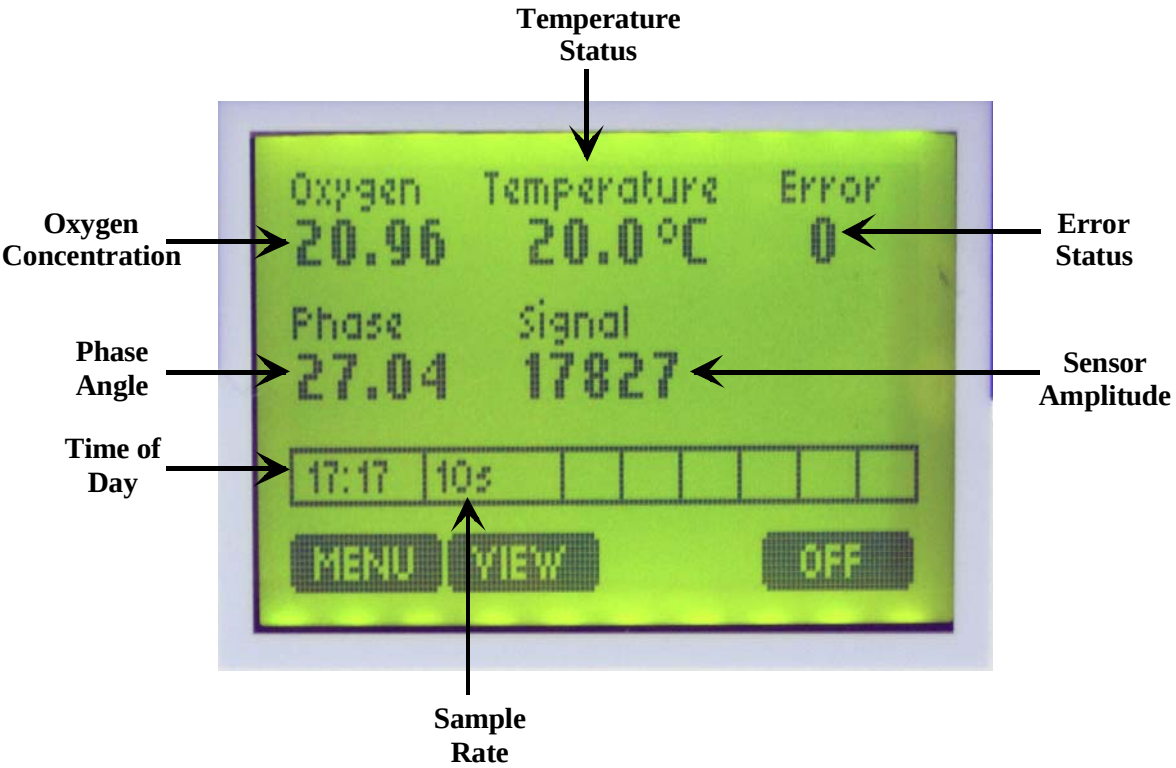
Apply power and switch on the instrument by pressing the button on the right side:



The instrument will power up and begin to measure with the settings of the last readings.
By pressing the VIEW (second button from left) you can choose between two different display views:



MAIN DISPLAY VIEW



ALTERNATE DISPLAY VIEW

10.2 Sensor Selection

Before starting the measurement you have to choose the correct sensor type. To set or change the sensor type you have to press the '***Menu'*** button and afterwards the '***Calibration'*** button. In the Calibration Menu you must scroll down to find the button 'Sensor type' and press enter to change the sensor. The following sensor types are available:

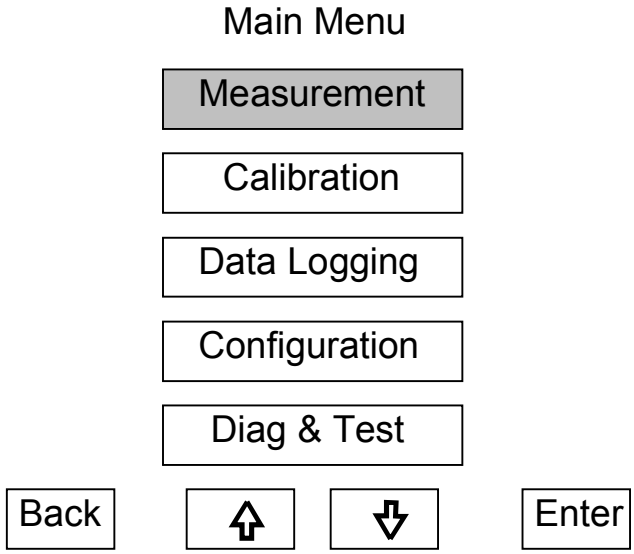
BOS2: oxygen sensor measuring in both the liquid and gas phase;
Measurement range: 0-250 % air-saturation (0-50 % oxygen)
Limit of detection: 0.15 % air-saturation

BOS1: trace oxygen sensor measuring in both the liquid and gas phase;
Measurement range: 0-20 % air-saturation (0-5 % oxygen)
Limit of detection: 1 ppb dissolved oxygen

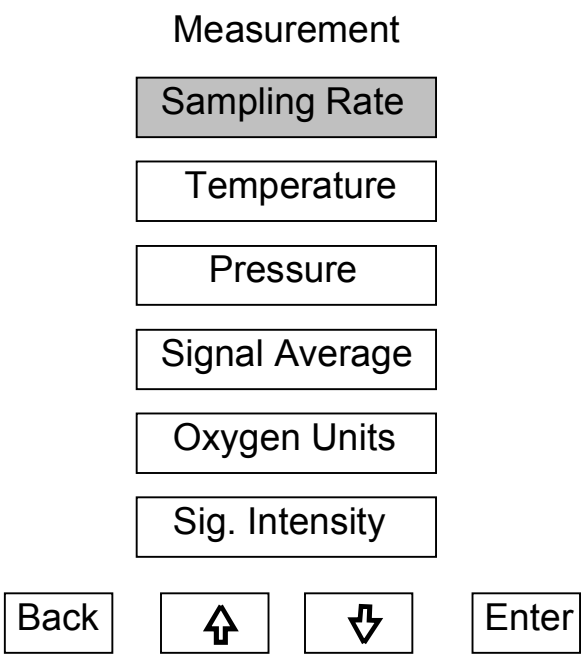
BOS3: trace oxygen sensor for gas phase measurements;
Measurement range: 0-200 ppm (1000 ppm Maximum) gaseous oxygen
Limit of detection: 0.5 ppm gaseous oxygen

10.3 Setting Measurement Parameters

Press the MENU button to enter the main menu:



Use the up and down buttons (Under display) to select. Press MEASUREMENT to enter the Measurement mode.



Use the up and down buttons to select. Press ENTER to change the respective settings:

Sampling rate: Press edit to change sampling rate and adjust the desired sampling rate. Use the up and down buttons to select the respective unit and confirm by pressing enter

Temperature: Press edit to change the temperature compensation:

Pt 1000 the temperature compensation has a temperature sensor connected

Manual allows the manual input of a constant temperature; Use the up and down buttons to select the desired temperature and confirm by pressing enter

External enables the input of a temperature signal by the analog inputs.
If analogue input channels are already configured (see chapter *Analog Inputs*) one can activate temperature compensation by mean of externally imported value. Here the external channel 1 or 2 can be easily selected.

NOTE:
Before starting external temperature compensation it is useful to check the quality of electrical signals. This can be done when the 4401 Oxy-trace v4 is NOT in "PC MODE". By entering "Diag & Test/Analog In" submenu the input voltage can be controlled directly on the front panel.

Pressure: Disabled – please contact our service team for further information

Signal averaging: Press edit to change Signal Averaging

Auto: The instrument itself chooses the best settings (default setting)

Manual: The higher the running average, the longer the time (sampling time) used for averaging. The higher the running average is set, the smoother the measurement signal

Oxygen units: Press edit to change the oxygen unit displayed. Use the up and down buttons to select the respective unit and confirm by pressing enter

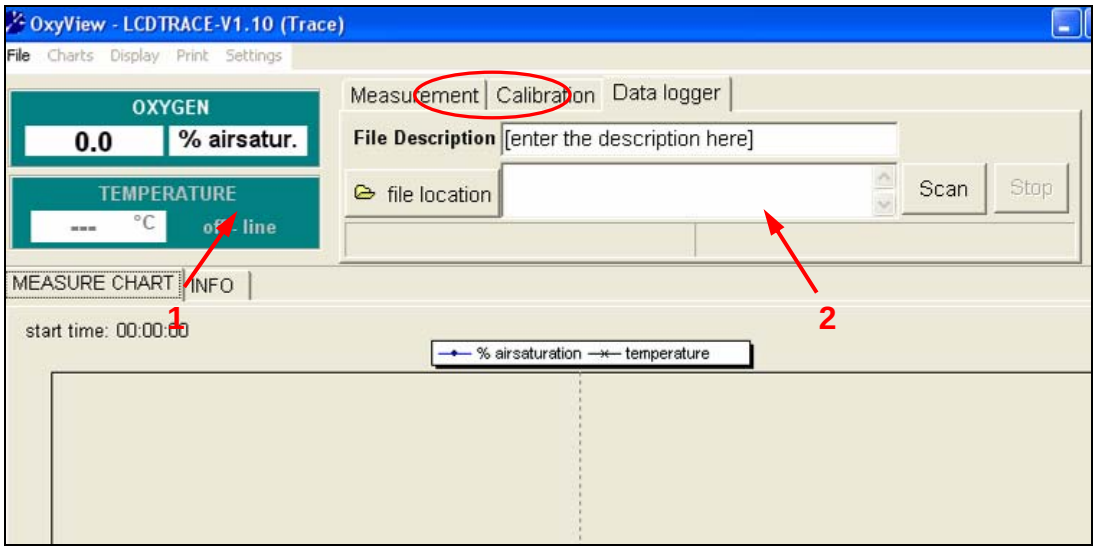
Sig. Intensity: Press edit to change the intensity of the signal LED. **Please notice that your calibration is not valid after changing this parameter!** Use the + and – button to adjust and press SET to confirm the settings. Values between 10 and 100 % are possible.

10.4 Data Logging

By default (delivery status) the data logger is turned off. In order to start data logging please go to **MENU** and select "**Data logging**" and "**Start**". To stop the recording please select "**Data logging**" and "**Stop**". The data logger status is available in "**Data logging**" and "**Status**" and shows several details such as starting time and date, sampling rate, saved records and free memory space. The maximal possible recording time depends on the selected sampling rate and is shown on the display after selecting '**Start**'.
During the recording (Data-logger activated) you cannot access other functions from the main menu. It is possible to turn off and restart the oxygen instrument again with Data-logger still ativated. The recording of data will be continuing immediately after the restart.

Important! When you stop the logging function and restart it, the previous records will be overwritten!

Stored records can be uploaded with the supplied *4401TRACEv113* (or higher) software by clicking on the '**Data logger**' button. After choosing the folder for saving data ('**file location**'), you have to click the '**Scan**' button and the software will show the stored number of data and the estimated download time. The download will be started automatically after confirming the shown details by clicking the '**Yes**' button.

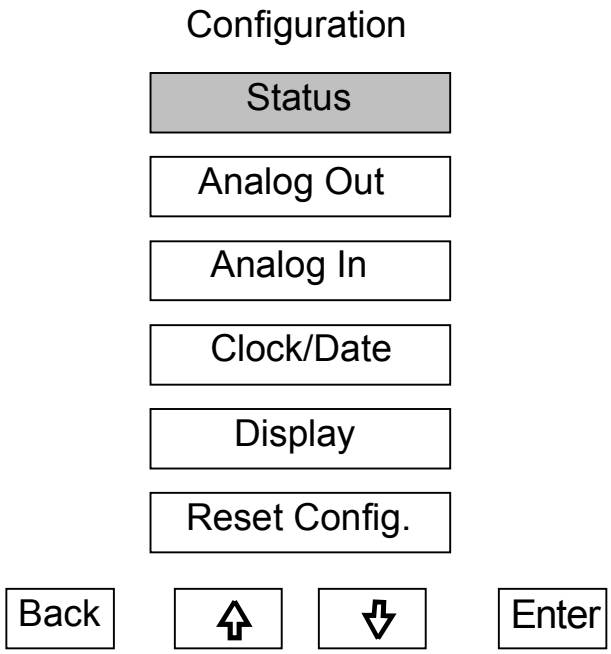


All records will be stored as a *txt-file* including date, time, amplitude, phase, temperature and oxygen.

Note! *Measurement logging* function (storage in PC) is not equal to *Data logger* function (storage in 4401 Oxy–trace NG).

10.5 Configuration Menu

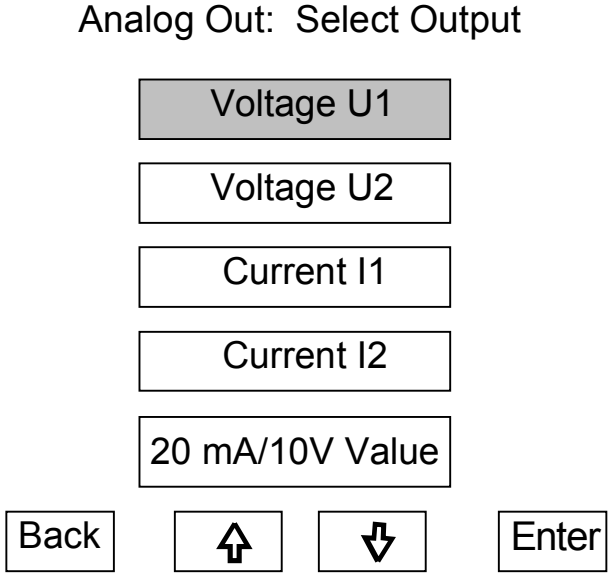
In this menu you can set most of your instrument parameters



Status: Displays the main settings of the instruments Press any button to turn back to the main menu

10.5.1 ***Analog out***:

Here you can choose which data are exported via the analogue outputs. The 4401 Oxy-trace v4 device has two voltage outputs (U1, U2) and two current output channels (I1, I2). The desired data sources (oxygen, temperature, amplitude, phase) can be chosen via the dialog box. All four output channels work independent on each other and are free programmable.



Voltage U1/U2: Select the parameter you want to activate as a Voltage analog output for port 1 and port 2 by using the arrow keys. The following output selections are possible:

- Inactive
- Oxygen
- Temperature
- Phase
- Amplitude

Current I1/I2: Select the parameter you want to activate as a Current mA analog output for port 1 and port 2 by using the arrow keys. The following selections are possible:

- Inactive
- Oxygen
- Temperature
- Phase
- Amplitude

20 mA/10 V value: Here you can program the correlation of the 10 V/20 mA value to the exported value.

i.e., 10 V can be set to 100 % air-saturation (20.95% v/v), then 1 V corresponds to 10% air-saturation
i.e., 10 V can be set to 200 ppm gaseous oxygen, then 1 V corresponds to 20 ppm

10.5.2 ***Analog In:***

Here you can choose which data is imported via the analog inputs. The
4401 Oxy-trace v4 device has two voltage input channels. The desired data sources temperature, pressure (*optional) can be chosen via the dialog box.

The purpose of input channels is to compensate the oxygen value with externally measured temperature or pressure. It is useful for a measurement set-up which has originally integrated temperature and/or pressure sensor. The user has a possibility to export the analog data from external sensor into 4401 Oxy-trace v4 via input channels. In order to initialize the input channels correctly, a proper measurement range must be set. Once set, the input voltage is used for oxygen calculation correction.

*Note 1: "Higher value" is the input voltage upper limit, and is equal to 10V for 4401 Oxy-trace v4. I.E.: If the input signal of 10V corresponds to temperature of 60°C, one should set the value in the **higher value control window** to 60.*

*Note 2: "Lower value" is the input voltage lower limit, and is equal to 0V for 4401 Oxy-trace v4. I.E.: If the input signal of 0V corresponds to temperature of 10°C, one should set the value in the **lower value control window** to 10.*

Example 1: Using the values given in note 1 and 2, the temperature correction upon the input voltage is:
By input voltage = 5V, the imported temperature will be 35°C
By input voltage = 7.5V, the imported temperature will be 47.5°C

Example 2: Suppose that input voltage of 0V ⇔ 500hPa, and 10V ⇔ 2000 hPa.
By input voltage = 3,5V, the imported pressure will be 1025 hPa
By input voltage = 5V, the imported pressure will be 1250 hPa
By input voltage = 7,5V, the imported pressure will be 1625 hPa

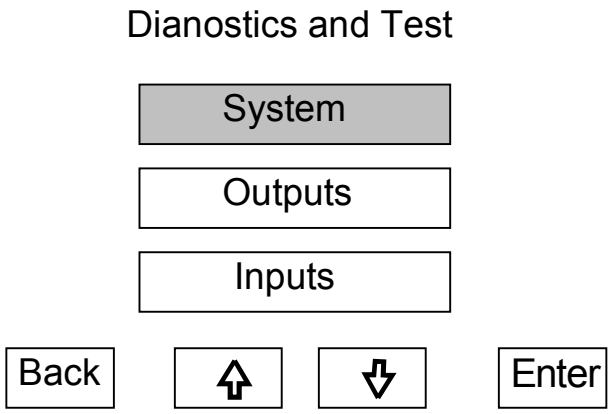
Clock/Date: Use + and next button to adjust clock and date and confirm with SET

Display: Changes the backlight illumination of the display – Auto switches on the illumination after pressing any button and switches it of after a few seconds again.

Reset configuration: Sets all parameters defined in this sub menu to default

10.6 Diagnostics and Test

This menu allows you to test the analog out and in ports



System: Displays the most important information of the instrument. Press any key to return to the main menu

Outputs: Choose the channel you would like to test with up and down buttons and confirm with enter. Adjust the test output value and check the value with your external data logger or voltmeter.

Inputs: Choose the channel you would like to test with up and down buttons and confirm with enter. The actual reading of the channel is displayed based on the input value.

11.0 CALIBRATION:

11.1 Calibration

The 4401 Oxy NG has been pre-programmed for the BOS 3 sensor (0 – 1000 ppm), if another measurement range above 1000 ppm is required you have to choose the correct sensor type (BOS1; 20 ppm to 4.2% v/v or BOS2; 50 ppm to 50% v/v). To change the sensor type you have to press the '***Menu'*** button and afterwards the '***Calibration'*** button. In the Calibration Menu you will find the selection "Sensor type" which you have to press to change the sensor.

Press **Status** to display the settings of your last calibration.
Press any button to return to the main menu

Press **Calibrate** to enter into the calibration menu and choose the calibration mode:

a) ***Temperature ON:*** Calibration with the actual temperature reading (either Pt1000, external or manual which is defined under Measurement – Temperature).

b) ***Temperature OFF:*** Calibration is completed without a temperature sensor, but with manual input.

c) ***Manual:*** Manual input of phase and temperature values

11.2 Calibration of the BOS3 oxygen sensor with Temperature compensation

- **Calibration with temperature compensation**

1) To calibrate the trace oxygen sensor with temperature compensation adjust sensor type BOS3 in the ***calibration menu*** under '***sensor type***'
2) Select in the '***Calibrate'*** menu the button '***temperature on***'
3) Adjust the atmospheric pressure and confirm it by pressing the '***Set'*** button
4) Adjust the concentration of the second calibration gas to 100 ppm (Calibration can be in the range between 10 and 300 ppm) and confirm it by pressing the '***Set'*** button
5) Connect the nitrogen (99.999%) calibration test gas to the sensor and turn on the regulator (1.5 LPM). ***Please ensure, not to create an overpressure and that no traces of oxygen can diffuse into your measuring system.***
6) Wait about 3 minutes until the phase angle and temperature are constant (the variation of the phase angle and the temperature should be smaller than ± 0.1° and ± 0.1°C) and press the '***Store***' button.
7) Turn off the Nitrogen test gas and disconnect from the sensor. Reconnect the "Span" calibration test gas (100 ppm oxygen) and turn on the 1.5 LPM regulator to start the second calibration point. ***Please ensure, not to create an overpressure or to contaminate your calibration chamber with air.***
8) Wait about 3 minutes until the phase angle and temperature are constant (the variation of the phase angle and the temperature should be smaller than ± 0.1° and ± 0.1°C) and press the '***Store***' button.
9) Now, calibration is complete. Turn off the regulator and remove the test gas from the sensor, rotate your valve to the sample position and begin you online measurement.
10) Press the "Menu" button to return to the main display to view your gas readings.

11.3 Calibration of the BOS3 oxygen sensor without Temperature compensation

- **Calibration without temperature compensation**

1) To calibrate the trace oxygen sensor without temperature compensation adjust sensor type BOS3 in the ***calibration menu*** under '***sensor type***';
2) Press in the '***Calibrate'*** menu the button '***temperature off***';
3) Adjust the temperature of the calibration standards and confirm it by pressing the '***Set'*** button;
4) Adjust the atmospheric pressure and confirm it by pressing the '***Set'*** button;
5) Adjust the concentration of the second calibration gas in ppm (optimally in the range between 10 and 300 ppm) and confirm it by pressing the '***Set'*** button
6) Connect the nitrogen (99.999%) calibration test gas to the sensor and turn on the regulator (1.5 LPM). ***Please ensure, not to create an overpressure and that no traces of oxygen can diffuse into your measuring system.***
7) Wait about 3 minutes until the phase angle and temperature are constant (the variation of the phase angle should be smaller than ± 0.1°) and press the '***Store***' button.

8) Turn off the Nitrogen test gas and disconnect from the sensor. Reconnect the “Span” calibration test gas (100 ppm oxygen) and turn on the 1.5 LPM regulator to start the second calibration point.
Please ensure, not to create an overpressure or to contaminate your calibration chamber with air.
9) Wait about 3 minutes until the phase angle and temperature are constant (the variation of the phase angle should be smaller than ± 0.1°) and press the ‘***Store***’ button.
10) Now, calibration is complete. Turn off the regulator and remove the test gas from the sensor, rotate your valve to the sample position and begin you online measurement.
Press the “Menu” button to return to the main display to view your gas readings

11.4 Calibration of the BOS3 oxygen sensor with Manual Temperature compensation

- **Manual Calibration**

User-defined calibration should be applied, if you don't ha ve the possibility to adjust the second calibration value via calibration test gas or if you don’t want to calibrate your sensor again. Barben Analyzers delivers an inspection sheet with each oxygen s ensor where you c an find two calibration values, which you have to enter in the user-defined calibration mode.

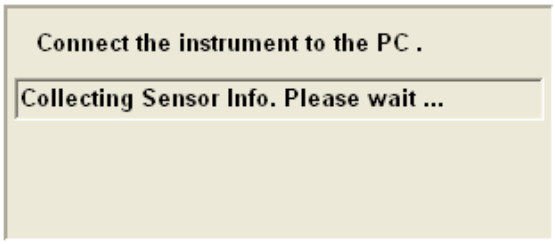
2) To calibrate the trace oxygen sensor with temperature compensation adjust sensor type BOS3 in the ***calibration menu*** under ‘***Sensor type***’;
3) Press in the ‘***Calibrate’*** menu the button ‘***Manual***’;
4) Adjust the cal 0 phase angle delivered with the sensor inspection sheet;
5) Adjust the concentration of the second calibration gas in ppm (optimally in the range between 10 and 300 ppm) and confirm it by pressing the ‘***Set’*** button;
6) Adjust the second calibration phase angle delivered with the sensor inspection sheet;
7) Adjust the temperature for the cal0 calibration value and confirm it by pressing the ‘***Set’*** button;
8) Adjust the temperature for the second calibration value and confirm it by pressing the ‘***Set’*** button;
9) To finish the manual calibration, adjust the atmospheric pressure and confirm it by pressing the ‘***Set’*** button

12.0 Description of the 4401 Oxy-trace NG PC Software

This software is compatible with Windows 98/2000/Millenium/NT4.0/XP.

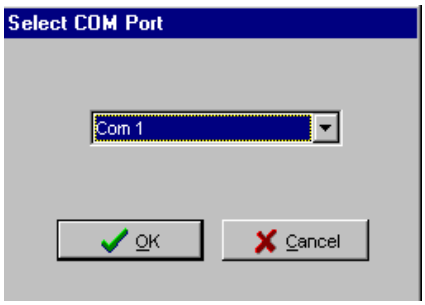
12.1 Software Installation and Starting the Instrument

1. Insert the supplied disc/CD into the respective drive. Copy the software file (*.exe) onto your hard disk. Additionally, you may create a link (Icon) on your desktop.
2. Connect the 4401 Oxy-trace v4 via the supplied serial cable to a serial port of your computer. Tighten the cable with the screws on your computer and connect the cable wires pins: (22 ground; 23 TxD; 24 RxD).
3. Apply power to the 4401 Oxy-trace v4
4. Please close all other applications as they may interfere with the software. Start the software with a double click. The following information window appears:



5. If the right com port is adjusted this information window disappears within a few seconds. If the wrong com port is adjusted you are asked to set the right com port:

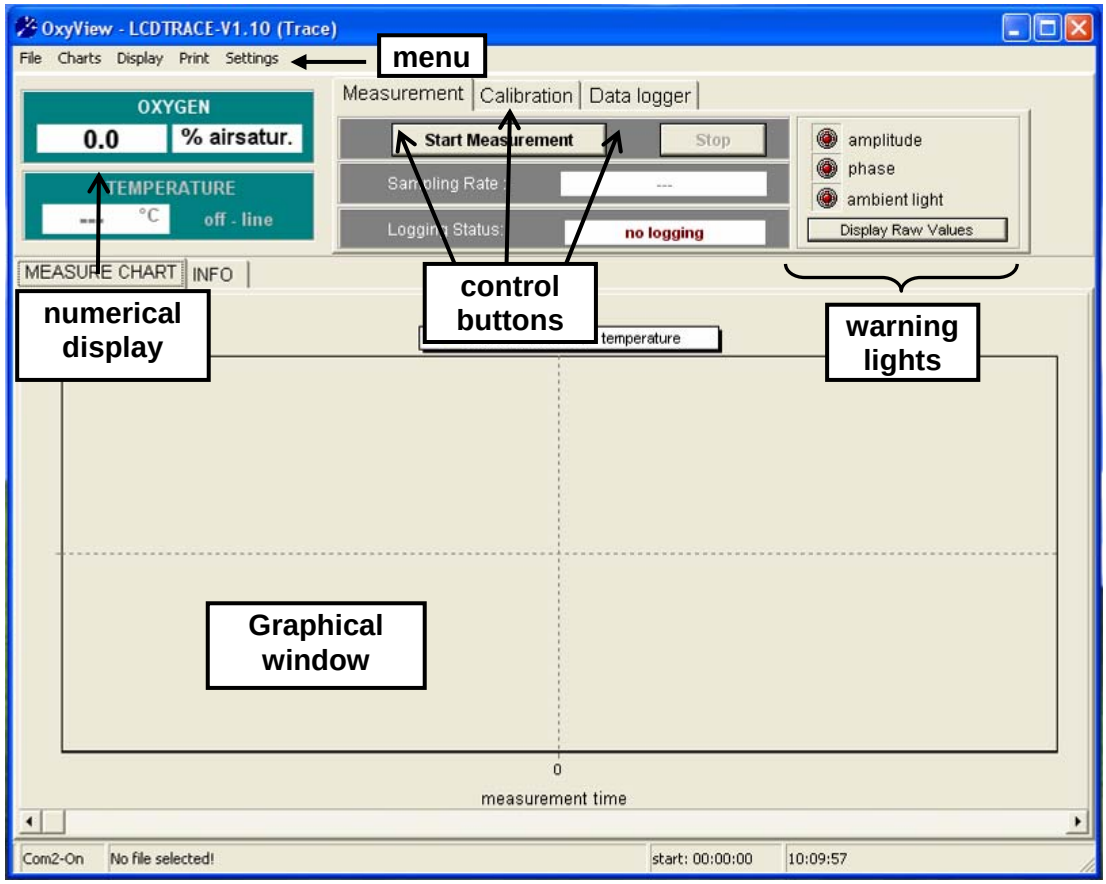
   With a left mouse click onto '***com port***' you are able to set the right com port. Please confirm your selection by clicking the '***OK***' button. The information window disappears if the right com port is adjusted.



12.2 Function and Description of the 4401 Oxy-trace v4 Program

The window shown below is displayed after starting the 4401 Oxy-trace v4 software:
The program has 4 main sections:

1. Menu bar
2. Graphical window
3. Status bar
4. Control bar, divided into numerical display, control buttons and warning lights.



12.2.1 Menu Bar

File	*Charts*	*Display*
→ Exit	→ Oxygen	→ Zoom → AutoScaleY1 → Undo Zoom
	→ Phase	
	→ Amplitude	→ Clear Charts
	→ Temperature	→ Dimensions

Print	*Settings*
→ Charts	→ Com Port
	→ Instrument Info
	→ analog output
	→ analog input
	→ LED Intensity
	➔ Sensor BOS2 BOS1 BOS2
	→ Oxygen Unit % air-saturation % oxygen hPa (mBar) Torr ppm / ppb µmol/L

File

Exit

Closes the program.

Charts

The respective charts of the measurement can be displayed (√) or hidden

Oxygen:
Oxygen content in the chosen unit

Phase:
Phase angle, the raw data

Amplitude:
The magnitude of the sensor signal

Temperature:
The measured temperature

12.2.2 Display

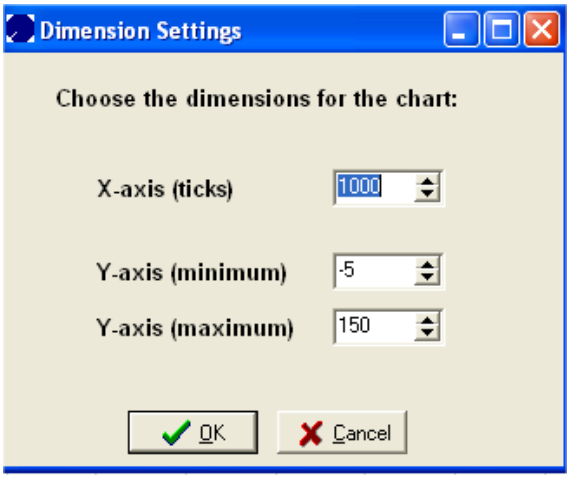
Zoom:

AutoScaleY1 is the default setting. AutoScaleY1 means that the y-axis is scaled automatically.

Undo Zoom: The original display is recovered; see also graphical display

Clear Charts: The graphs shown on the display is cleared.

Dimensions*:*



You can adjust the number of measurements points on the x-axis shown in the display (maximum number of points are 5000)

Furthermore, you can adjust the minimum and the maximum of the y-axis.

The AutoScaleY1 function is switched off.

Print

Charts: *The charts shown in the display can be printed*

Settings

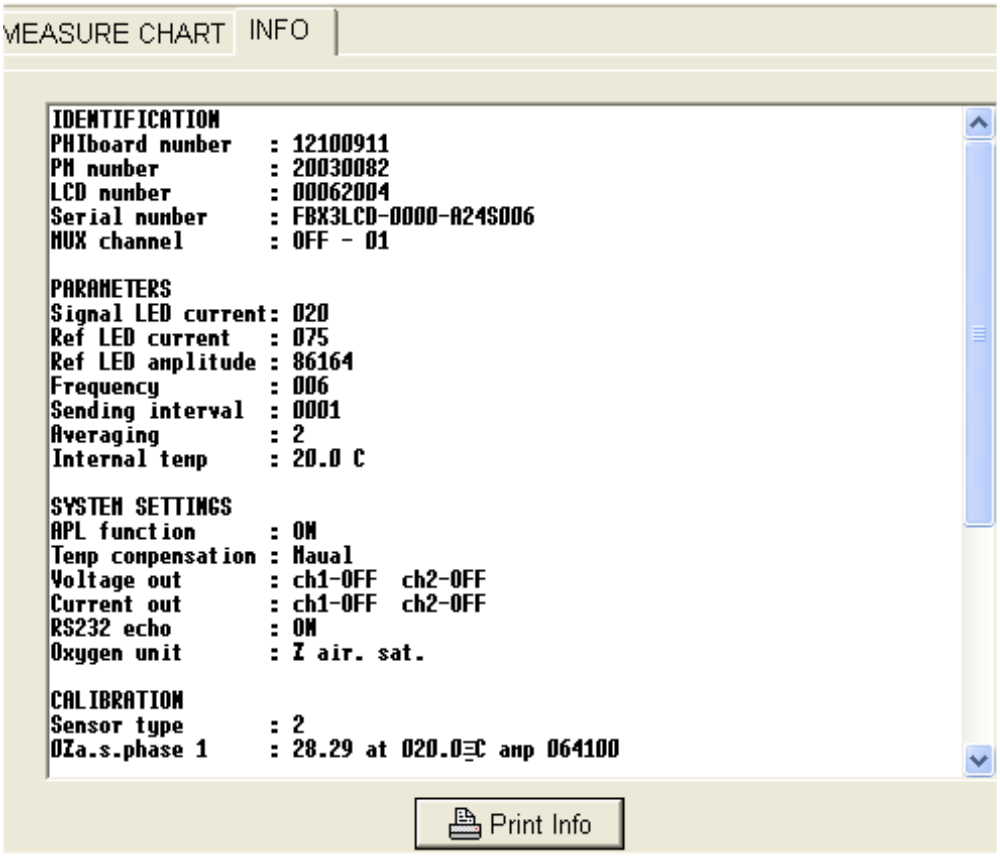
- ***ComPort***

The serial comport (com1 – com2 0) for the serial interface (RS 232) can be chosen in this window. COM 1 is the default setting. If you choose the wrong Com port, the information window '***Connect the instrument to the PC and choose the right com-port***' will appear and you must select the correct com port.

- ***Instrument Info:***

Here you can find the version of the software and additional important settings of the instrument. If you ha ve a problem with the 4401 Oxy-trace v4 oxygen meter, please contact our service team and have the software and instrument information ready for assistance in trouble shooting.
To change back to the graphical window click the '***Measure Chart***' button.

12.2.3 *Instrument Information*



Software Information

Barben Analyzer Technology LLC

5200 Convair Drive

Carson City, Nevada 89706

Version 8

12.3 LED-Intensity

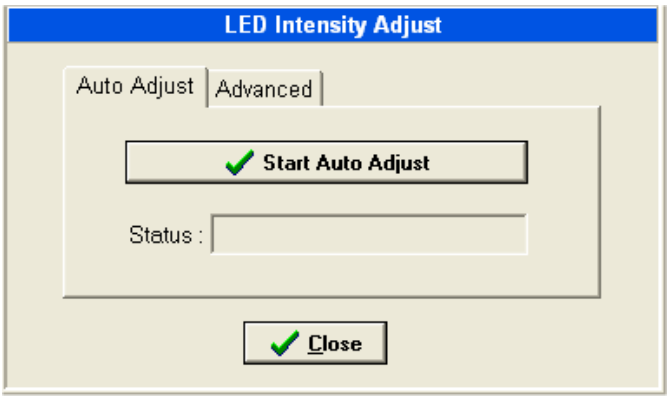
With the current of the LED you can adjust the amount of light illuminating the sensor spot.

You can choose between an ' **Auto Adjust**' of the LED where the 4401 Oxy-trace v4 adjusts the optimal LED current itself, or you can select '**Advanced**' where you can adjust the LED current yourself.

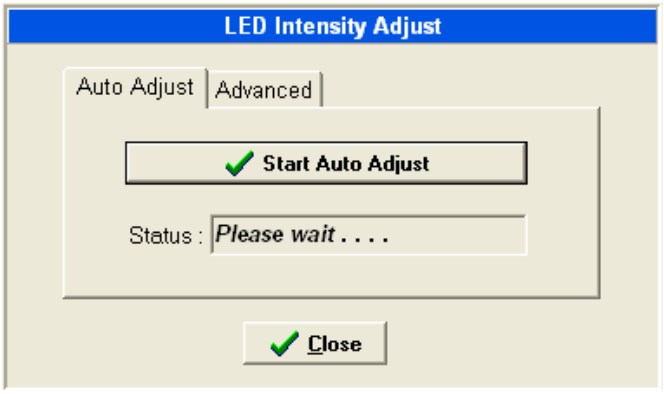
If you increase the LED current, the signal amplitude increases, since a higher light density illuminates the sensor spot.

Auto Adjust:

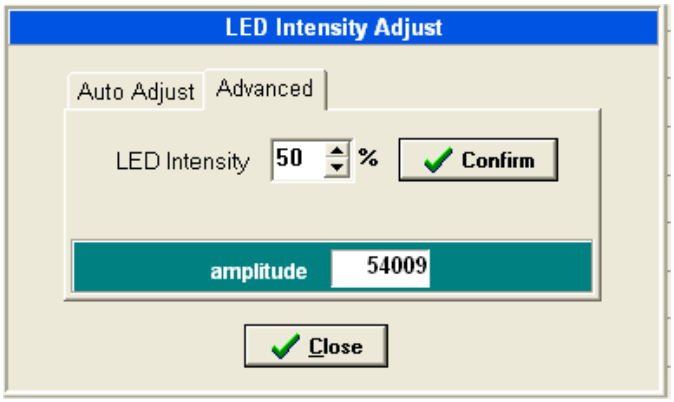
To make the adjustment of the LED intensity automatically, just click the button '**Start Auto Adjust**'. Please check that the oxygen sensor has been connected to the instrument.



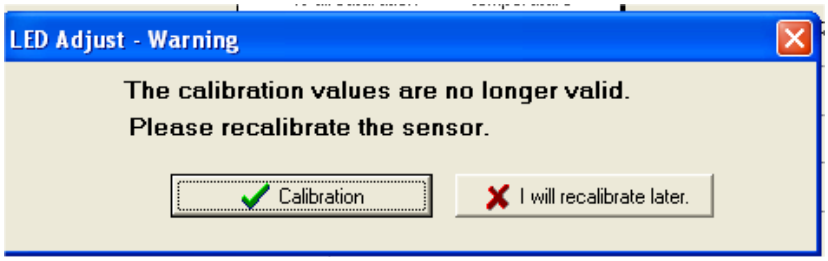
The automatic adjustment of the LED intensity is completed when in the status window the message '**Auto adjustment finished**' appears. Click the '**Close**' button to confirm the settings.



Advanced:
Click the '**Advanced**' button to change the LED current manually. Values between 10 and 100 % are possible. After clicking the 'confirm' button you can see the change of the amplitude in the window below.



Please note, that after changing the LED intensity you should re-calibrate the oxygen micro-sensor. A warning window points you to re-calibrate the oxygen micro-sensor.


LED Adjust - Warning
The calibration values are no longer valid.
Please recalibrate the sensor.
Calibration
I will recalibrate later.

Please note:

By increasing the light intensity you increase the amplitude of the oxygen sensor. This leads to smoother phase signals. However, increasing the light intensity can increase photo-bleaching, which decreases the shelf-life of your sensor.

- ***Sensor***

Before starting the measurement you have to choose the correct sensor type. To change the sensor type you have to press the '***Sensor'*** in the Menu point '***Settings***'. The following sensor types are available:

BOS2: oxygen sensor measuring in both the liquid and gas phase;
Measurement range: 0-250 % air-saturation (0-50 % oxygen)
Limit of detection: 50 ppm gas phase

BOS1: trace oxygen sensor measuring in both the liquid and gas phase;
Measurement range: 0-20 % air-saturation (0-5 % oxygen)
Limit of detection: 20 ppm gas phase

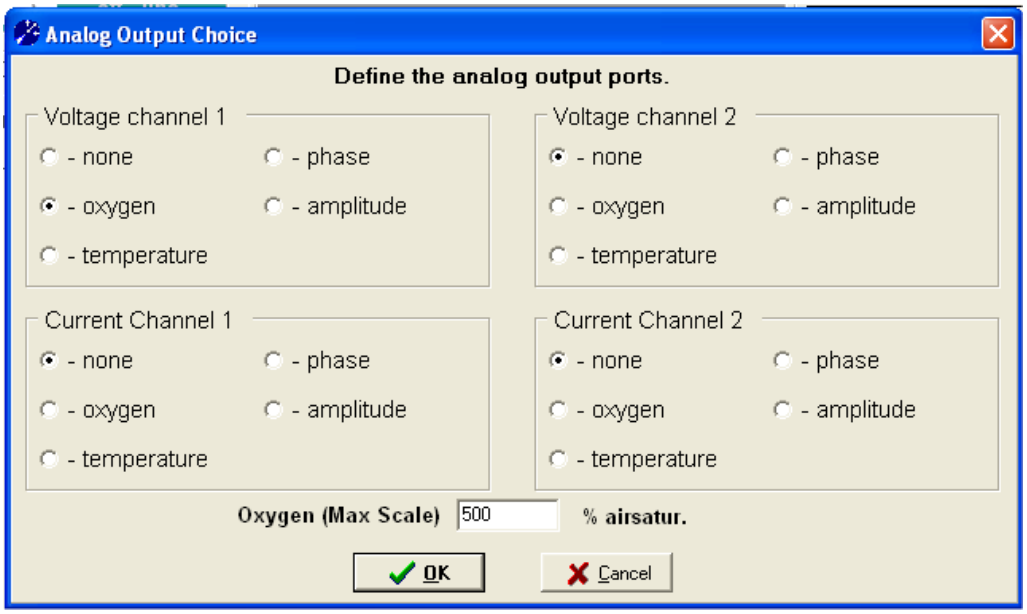
BOS3: trace oxygen sensor for gas phase measurements;
Measurement range: 0-200 ppm (maximum 0 – 1000 ppm) gaseous oxygen
Limit of detection: 0.5 ppm gaseous oxygen

12.4 Oxygen Unit

Here you can adjust the desired oxygen unit. Tables and formulas for th e calculation of different concentration scales are given in the appendix.

12.5 Analog output

Here you can choose what data is exported via the analog outputs. The 4401 Oxy-trace NG device has t wo voltage outputs and two current output channels. The desir ed data sources (oxyge n, temperature, amplitude, phase) can be chosen via the dialog box (see figure belo w). All four output channels work in dependent on each other.



Oxygen (Max Scale): Here you can program the correlation of the 10 V/20 mA value to the exported value.
i.e., 10 V can be set to 500 % air-saturation, then 1 V corresponds to 50% air-saturation
i.e., 10 V can be set to 200 ppm gaseous oxygen, then 1 V corresponds to 20 ppm

To change the oxygen unit you have to go to settings, oxygen unit, and adjust the desired unit.

12.6 Analog input

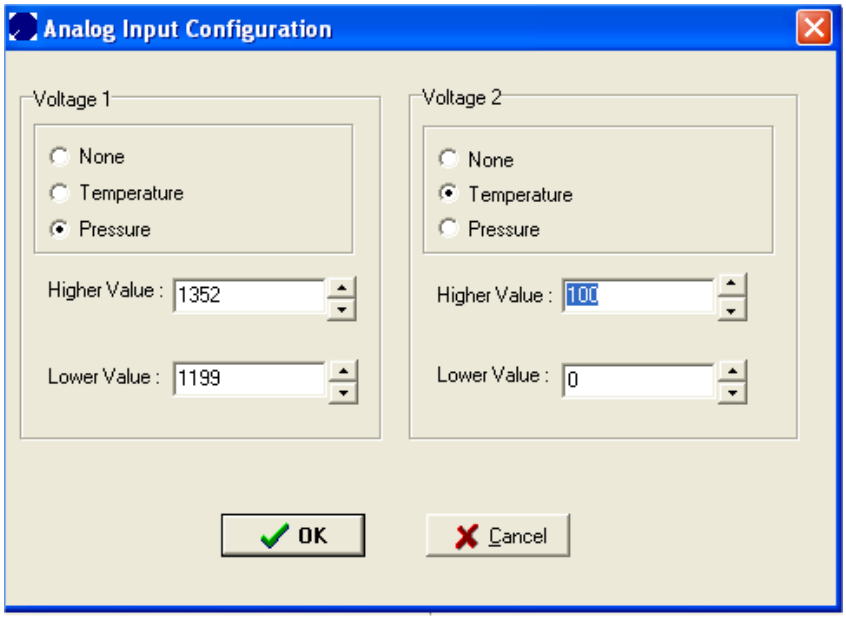
Here you can choose what data is imported via the analog inputs. The 4401 Oxy-trace v4 device has two voltage input channels. The desired data sources temperature, pressure (*option) can be chosen via the dialog box (see figure below).
The purpose of input channels is to compensate the oxyg en value with externally measured temperature or pressure. It is useful for a measure ment set-up which has originally int egrated temperature and/or pressure sensor. The user has a possibility to export anal ogue data from e xternal sensor into 4401 Oxy-t race via input channels. In order to ini tialise the in put channels correctly, a proper measurement range must be set. On ce set, the input voltage is used for oxygen calculation correction.

Note 1: *"Higher value" is the input voltage upper limit, and is equal to 10V for 4401 Oxy-trace NG. I.E.: If the input signal of 10V corresponds to temperature of 60°C, one should set the value in the* ***higher value control window*** *to 60.*

Note 2: *"Lower value" is the input voltage lower limit, and is equal to 0V for 4401 Oxy-trace NG. I.E.: If the input signal of 0V corresponds to temperature of 10°C, one should set the value in the* ***lower value control window*** *to 10.*

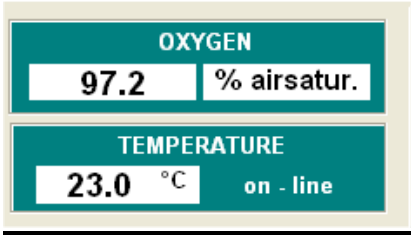
Example 1: *Using the values given in note 1 and 2, the temperature correction upon the input voltage is:*
By input voltage = 5V, the imported temperature will be 35°C
By input voltage = 7.5V, the imported temperature will be 47.5°C

Example 2: *Suppose that input voltage of 0V ⇔ 500hPa, and 10V ⇔ 2000 hPa.*
By input voltage = 3.5V, the imported pressure will be 1025 hPa
By input voltage = 5V, the imported pressure will be 1250 hPa
By input voltage = 7,5V, the imported pressure will be 1625 hPa



12.7 Control Bar

Numerical display



The actual oxygen content in the chosen unit (here % air-saturation) is displayed in the oxygen window. Tables and formulas for the calculation of different concentration scales are given in the appendix.

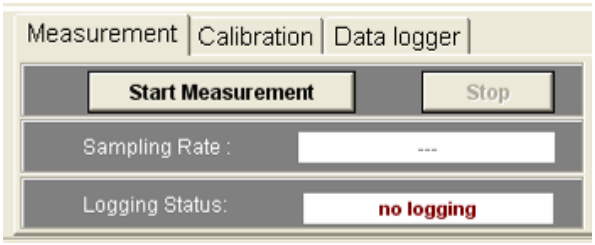
Temperature measurement:
The actual temperature value of the sample (in the case of temperature compensated measurements) is displayed in the temperature window.

If measurement is performed without temperature compensation, the manual inserted temperature is displayed and that temperature measurement is shown off–line.

Control buttons:

The way to start a measurement is

(A) Calibration of the mini-sensor with the Calibration Assistant
(B) Start Measurement with measurement Assistant
(C) Readout Data-logger

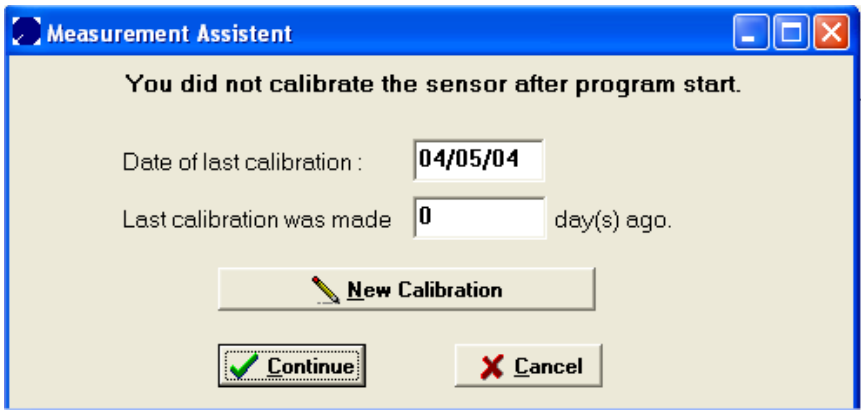


(A) Calibration:

The calibration assistant will open (see Calibration of Oxygen Sensors);

(B) Measurement:

By clicking '***Start Measurement***' the measurement assistant opens to enter the measurement settings.
If you haven't performed sensor calibration yet the following window appears



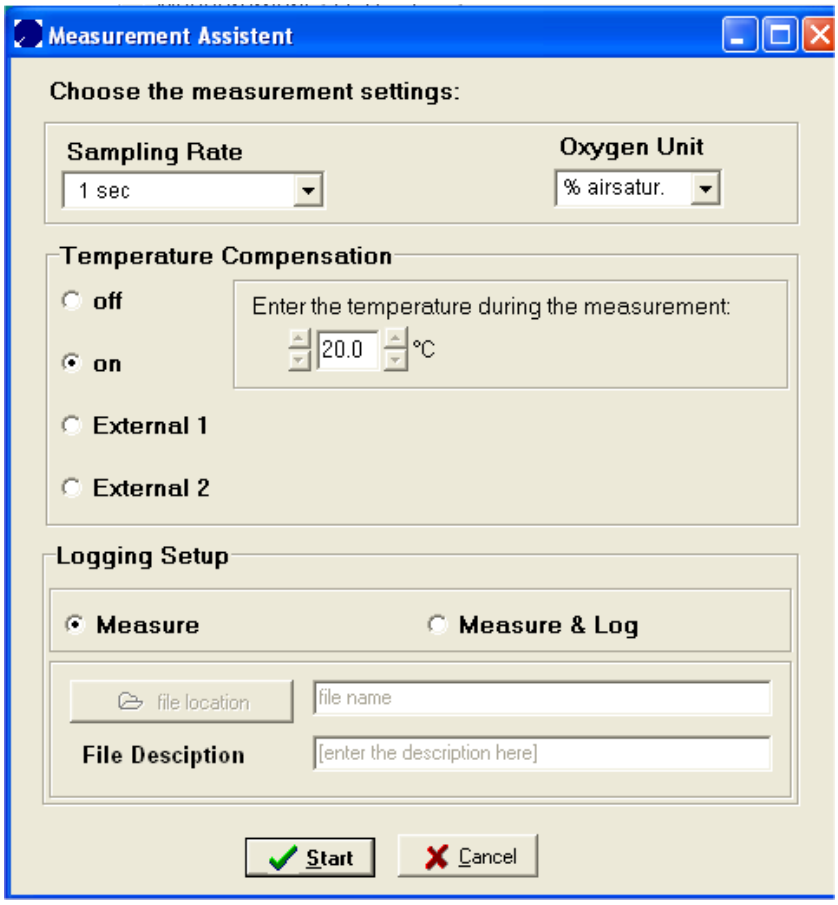
If you want to measure with the last sensor calibration - you can find the '***date of the last calibration***' in the window - click the '***Continue***' button. To obtain reliable results we strongly recommend performing a sensor calibration before measurement by clicking the '***New calibration***' item when connecting a new sensor.

Follow the instructions given in chapter 7 to calibrate the respective sensor.

To leave this menu, click the '***Cancel***' button.

If you have already performed sensor calibration, the measuring assistant will open.

In this window you can choose the measurement settings:



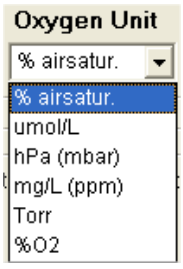
In the '**Sampling Rate**' window you can select the desired measurement mode with a drop-down menu.

By clicking the drop down menu you can choose from '***1s***' to the '***60 min***' mode where each hour a measuring point is recorded.

Please note:

The sensor shelf life can be increased using a slower Sampling rate since the effect of photo-bleaching is reduced. The illumination light is turned off between sampling. A further advantage using a higher measuring mode is that huge amounts of data for long-time measurement can be avoided.

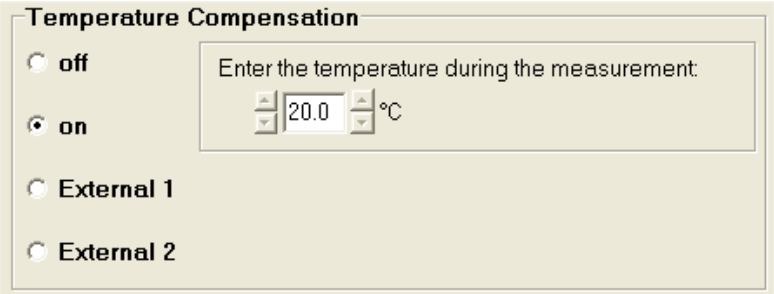
Oxygen Unit:



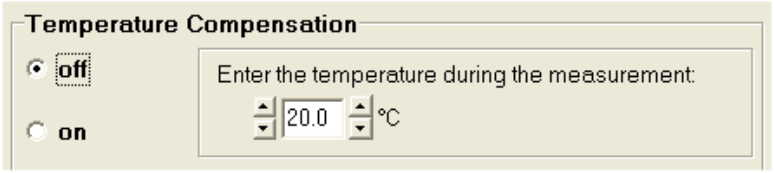
With this drop down menu, you can select the desired oxygen unit. Tables and formulas for the calculation of different concentration scales are given in a supplemental catalog.

12.7.2 *Temperature Compensated Oxygen Measurements:*

If you want to measure with temperature compensation, click the '***on***' button. Please ensure that the temperature sensor Pt 1000 is connected to the 4401 Oxy-trace v4, before you click the '***Start***' button to continue. The window where you can enter the temperature manually is disabled.



If you want to measure without temperature compensation, choose the '***off***' button. Please enter the temperature of your measurement sample manually. Click the '***Start***' button to start the measurement.



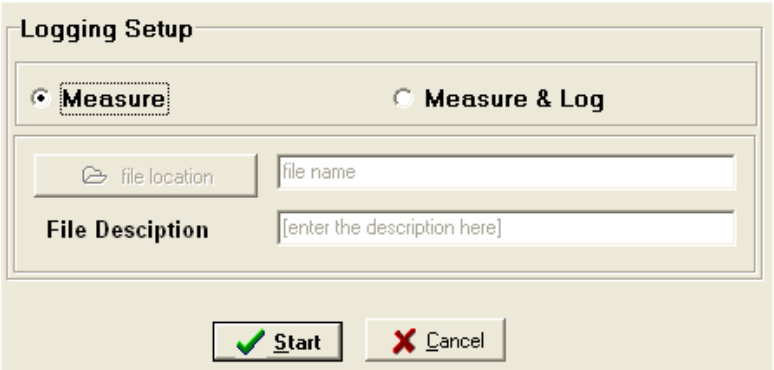
12.7.3 External Temperature Compensation:

If the analog input channels are already configured (see chapter *Analog Inputs*) one can activate temperature compensation by mean of externally importing value. Here the external channel 1 or 2 can be easily selected.

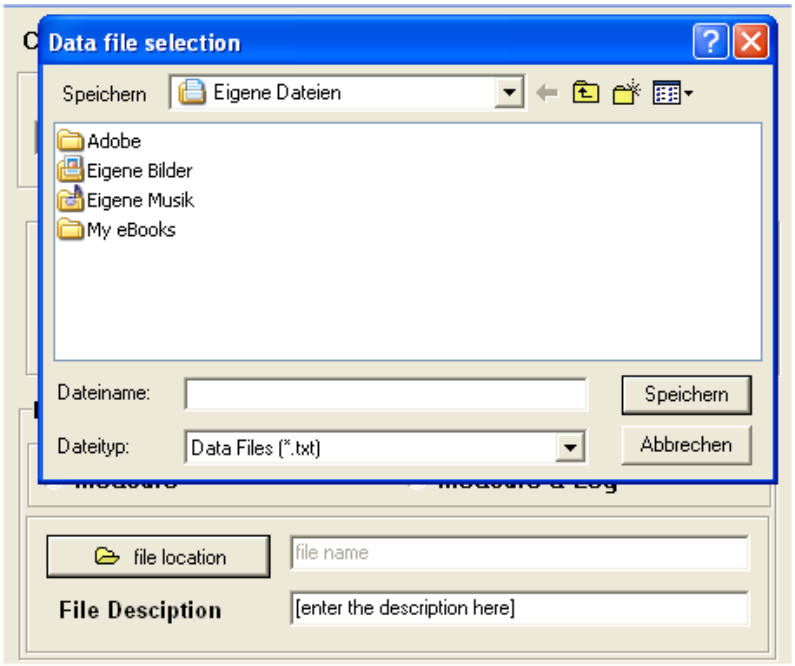
*NOTE: Before starting external temperature compensation it is useful to check the quality of electrical signals. This can be done when 4401 Oxy-trace NG is NOT in "**PC MODE**". By entering "**Diag&Test/Analog In**" submenu the input voltage can be controlled directly on the LCD.*

Logging Setup:

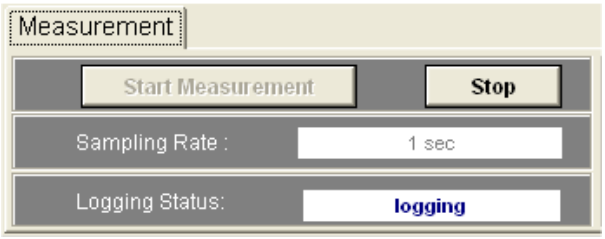
To start the measurement without logging data click '***Measure***' in the Logging setup and the '***Start***' button.



To store the data of you r measurement click in t he '***Logging Setup***' the '**Measure & Log**' item and click th e button '***Choose File***'. Here you c an select th e location where you want to store the data. Choose as file extension ****.txt***. Click the '***speichern***' (SAVE) button to confirm your settings.



You can enter a measurement description in the text field '***File description***' which is stored in the ASCII File. To start the measurement, click the '***Start***' button. In the Information windows '***Sampling Rate***' you can find the adjusted sampling rate. To be sure whether you perform a measurement with or without logging the data, the '***Logging Status***' window displays whether the actual measurement is stored to a file (***logging***) or not (***no logging***);



Stopping the Measurement:

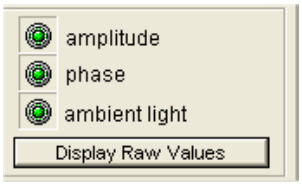
The measurement is ended by a left click on the '***stop***' button in the control bar.

12.7.4 Downloading the Data-logger Data

Look at chapter 6.5 for this function and for the download from the stored data in the 4401 oxy instrument!

12.7.5 Warning Lights:

At the right bottom of the window you can find the amplitude, phase angle and three warning lights. The warning lights are explained below:

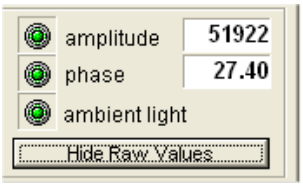


Amplitude: **Red**: Amplitude is too low, the sensor tip may be damaged or sensor cable may not be connected
Yellow: Amplitude is critically low, replacement of the sensor is recommended
Green: amplitude level is good

Phase: **Red**: phase angle is out of limits
Green: phase angle is in the normal range

Ambient light: **Red**: background light (e.g. direct sunlight, lamp) is too high. Decrease of background light is required
Green: ratio of sensor signal to false light is acceptable

By clicking the 'Display Raw Values' button, the raw data of phase angle and amplitude are displayed next to the warning lights.



12.7.6 Graphical Display Window

The respective sensor signal is displayed according to the selection of the 4 control buttons oxygen, phase, amplitude and temperature (menu chart). The oxygen content is displayed in the chosen unit, the temperature in °C. The raw values (the phase angle in degrees and the sensor amplitude in mV) can also be displayed by clicking the button ***'Display Raw values'***.

Zoom Function:

1. Press the left mouse button and drag from left to right to enlarge a certain area of the graphical window. The graphical window displays the selected data points and is not actualized with new data.
2. Press the left mouse button and drag from right to left to recover the original display, or click the ' **Undo Zoom**' button in the *display* menu under *zoom*.

Status Bar

sw1: Displays the serial port which is used for communication of the 4401 Oxy-trace v4 device with the PC
sw2: Displays the file name in which the measurement data are stored. „No storage file selected“ is displayed if no file was selected (no data storage).
sw3: Displays the start time of the measurement
sw4: Displays the actual time

13.0 Error Codes

The error value is binary coded. It means each bit corresponds to one specific error or warning. The summary of error bits is given below:

bit 0 = ADC overflow
bit 1 = Ambient light
bit 2 = no oxygen sensor
bit 3 = no temperature sensor
bit 4 = current output 1 open loop error
bit 5 = current output 2 open loop error
bit 6 = overheat
bit 7 = system restart

Decoding example

If Error value received from a device is **10** then a following error has occurred:

Decimal **10** = Binary **00001010**

Here bit1 ⇔ ambient light and bit3 ⇔ no temperature sensor are “1”. This error code would appear if there was too much of ambient light (sun light illuminating the sensor) and the temperature sensor PT1000 is not connected to the device.

Binary Table

0001 = 1	0110 = 6	1011 = 11
0010 = 2	0111 = 7	1100 = 12
0011 = 3	1000 = 8	1101 = 13
0100 = 4	1001 = 9	1110 = 14
0101 = 5	**1010 = 10**	1111 = 15

13.1 Saved Data Handling

In the heading of the ASCII file, you find the **description** of your measurement which you have entered by storing the file.
Below you find the ‘ ***instrument info***’ containing the data of the complete calibration routine and some additional important settings of the instrument and firmware.
The ‘***software info***’ below contains the version number of the 4401 Oxy-trace NG software, date and time of the performed measurement. If there is a problem with the 4401 Oxy-trace NG oxygen meter, please contact our service team and have the software and instrument information ready.
Below, you find the ‘***measure mode settings***’ containing the *dynamic averaging*, and the *measuring mode*.

The following rows, separated by semicolons, list the measuring data. The first two rows contain the **date** and **time**, the third the **log-time** in minutes, the fourth the **oxygen content** in the chosen unit. The raw data - **phase angle** in [°] and the **amplitude** in [mV] - are stored in the fifth and sixth row, respectively. The seventh row contains the **temperature** in °C measured by PT1000 temperature sensor. Raw data can be used for user defined recalculations according to the formulas and tables listed in the appendix.

In the last row possible error codes are listed.

```
***** DESCRIPTION **********
test measurement

***** INSTRUMENT INFO *******
IDENTIFICATION
PHIboard number   : 12100911
PM number         : 20030082
LCD number        : 00062004
Serial number     : FBX3LCD-0000-A24S006
MUX channel       : OFF - 01

PARAMETERS
Signal LED current: 020
Ref LED current   : 075
Ref LED amplitude : 82440
Frequency         : 006
Sending interval  : 0001
Averaging         : 2
Internal temp     : 29.6 C

SYSTEM SETTINGS
APL function      : ON
Temp compensation : AUTO
Voltage out       : ch1-OFF  ch2-OFF
Current out       : ch1-OFF  ch2-OFF
RS232 echo        : ON
Oxygen unit       : % air. sat.

CALIBRATION
Sensor type       : 2
0%a.s.phase 1     : 58.19 at 021.7?C amp 078300
100.00%a.s.phase 2: 28.09 at 019.5?C amp 071700
Date   (ddmmyy)   : 030504
Pressure (mBar)   : 1015

FIRMWARE
Code 3.010 (LCD)  : 04/28/04, 14:13:28
Xilinx built      : 20/08/02 (MM/DD/YY)
Reset condition   : SLEEP

***** SOFTWARE INFO *********
OxyView - LCDPST3-V1.01 03/2004
? by PreSens GmbH
  03.05.2004
    07:28:51

******MEASURE MODE SETTINGS**
Dynamic Ave                1
measure mod  1 sec

start time       07:28:46
date(DD/MM/Y time/hh:mm:s logtime/sec   oxygen/% air  phase/?      amp          temp/?C      ErrorMessage
  03.05.2004   07:28:51:02        0.02          2.51        56.31       83616          19.1  E0
  03.05.2004   07:28:51:79       0.036          2.45        56.36       83739          19.1  E0
  03.05.2004   07:28:52:64       0.053          2.47        56.34       83615          19.1  E0
  03.05.2004   07:28:53:64        0.07          2.44        56.37       83731          19.1  E0
  03.05.2004   07:28:54:64       0.086          2.47        56.34       83736          19.1  E0
  03.05.2004   07:28:55:64       0.103          2.47        56.34       83715          19.1  E0
  03.05.2004   07:28:56:65        0.12          2.45        56.36       83717          19.1  E0
  03.05.2004   07:28:57:65       0.136          2.45        56.36       83687          19.1  E0
  03.05.2004   07:28:58:64       0.153          2.47        56.34       83712          19.1  E0
  03.05.2004   07:28:59:64        0.17          2.44        56.37       83939          19.1  E0
  03.05.2004   07:29:00:64       0.186           2.4         56.4       84031          19.1  E0
```

Concentrations units are calculated from % air-saturation by the software. Consequently, changes in the actual atmospheric pressure have no effect on the partial pressure units (hPa, Torr) and concentration units (mg/L, µmol/L) but the oxygen units % air-saturation and % oxygen-saturation have to be corrected for air pressure change.

13.2 Some Advice for Correct Measurement

Calibration of the sensor is recommended before each new application. If you don't want to recalibrate a sensor, you can use the calibration values of your last measurement (see "*User-Defined Calibration*"). Ensure that the temperature of the sample is known and is constant during measurement, if you do not use temperature compensation. In the case of temperature-compensated measurements, the temperature sensor Pt 100 should be positioned as close as possible to the oxygen mini-sensor to avoid temperature differences. Please consult the special information on our Website www.BAT4ph.com or contact our service team if you are in any doubt.

13.3 Signal drifts due to oxygen gradients

Please, keep in mind, that the sensor only measures the oxygen content near its surface. If the vessel or pipeline is not moving it may cause an oxygen concentration gradient.

The formation of a bio-film during long term measurements or the accumulation of other sample components like oil or solid substances may lead to an oxygen gradient.

13.4 Signal drifts due to temperature gradients

A further source of imprecise measurement is insufficient temperature compensation. If you use the temperature compensation, ensure that no temperature gradients exist between the oxygen sensor and the temperature sensors. If you measure without temperature compensation, please bear in mind, that the 44 01 Oxy-trace v4 only measures correctly, if the sample temperature is constant during measurement and the temperature is the same as you entered in at the beginning of the measurement. If the temperature is measured with a precision of ± 0.2 °C, there is a variation in the measuring value at 100% air-saturation of ±0.7 % air-saturation. Please select the measurement with temperature compensation to minimize temperature gradients.

13.5 Signal drift due to photo-decomposition

The oxygen-sensitive material may be subject to photo-decomposition resulting in a signal drift. Photo-decomposition takes place only during illumination of the sensor tip and depends on the intensity of the excitation light. Therefore, the excitation light should be minimized. Continuous illumination of a **BOS2** oxygen sensor over a period of 24 hours may lead to a phase drift of up to + 0. 4 % air-saturation measured at 100% air-saturation at 20°C. However, this effect of photo-decomposition can even be minimized, by changing the measuring mode to the 30 second or minute interval mode. In these modes, the software switches off the excitation light after recording the data point and switches it on after the interval you have chosen.
Please use the interval method whenever it is possible to increase the operational life of the sensor.

Sensor Drift at 0 % air-saturation (0 ppb) recording 3600, 50000 and 100000 data points.

	Drift per 3600 points	Drift per 50000 points	Drift per 100000 points
BOS2	< 0.15 % air-sat.	< 0.15 % air-sat.	< 0.25 % air-sat.
BOS1	< 1 ppb	< 2 ppb	< 3 ppb

*Drift in % air-saturation at 100% air-saturation when illuminating the oxygen sensor **BOS2** for 1, 12 and 24 hours in the continuous mode.*

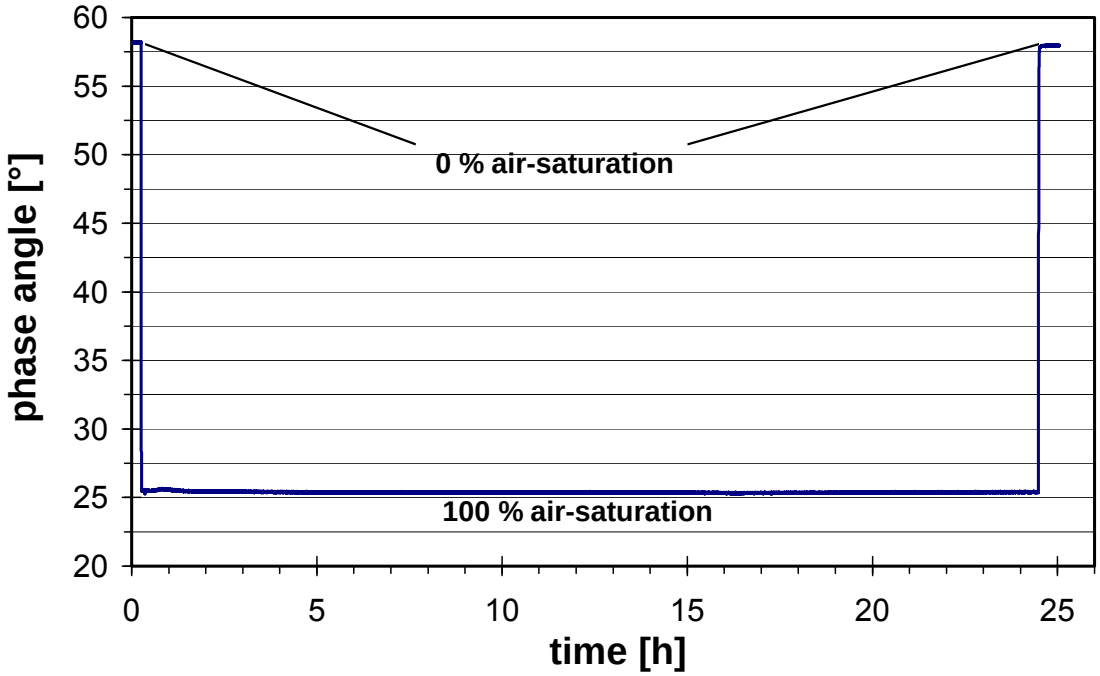
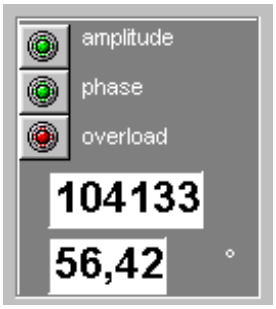


Photo-decomposition test of **BOS2**, continuously illuminating the sensor membrane for 25 hours

13.6 Signal drift due to too much ambient light



A source of error is the detector overload due to too much ambient light. A detector overload can be recognized with the red shining warning light ***overload***, which you can find at the right bottom of the window.

Red: Background light (i.e., direct sunlight, lamp) is too high. Decrease of false light by decreasing the light intensity or darkening the sample is necessary.

Green: Ratio of sensor signal to false light is acceptable

Please note, that your measurement is not reliable if the warning light overload is shining red. A detector overload causes a decrease in both amplitude and phase angle.

13.7 Performance Verification

If you want to prove the performance during the past measurements, please check the calibration values by using your calibration test gases for "0" (UHP Nitrogen 99.999%) and the Span test gas (100 ppm oxygen/N2). This can be completed by using a 3 way valve connected to your test gases enabling you to switch back and forth from the different bottles. This will verify proper operation.

13.8 Correction for air-pressure variations

The atmospheric pressure of the calibration is needed to convert the oxygen unit % air-saturation in partial pressure units (hPa, Torr) or concentrations units (mg/L µmol/L). The partial pressure and the oxygen concentrations units are calculated from % air-saturation by the software. Consequently, changes in the actual atmospheric pressure have no effect on the partial pressure units (hPa, Torr) and concentration units (mg/L, µmol/L) but the oxygen units % air-saturation and % oxygen-saturation have to be corrected for air pressure change.

14.0 Technical Data

14.1 General Data

MODES	
BOS2 oxygen sensor	range: 0 - 250 % air-saturation
BOS1 oxygen sensor	range: 0 - 20 % air-saturation
BOS3 oxygen sensor	range: 0 - 1000 ppm gaseous oxygen
Temperature	range: 0 - 50 °C resolution: ± 0.5 °C accuracy: ± 1° C

CALIBRATION PROCEDURE	
BOS2 oxygen sensor	2-point calibration in a oxygen-free atmosphere and a second calibration gas or ambient oxygen
BOS1 oxygen sensor	2-point calibration in a oxygen-free atmosphere and a second calibration gas in the range between 1% and 2 % oxygen
BOS3 oxygen sensor	2-point calibration in a oxygen-free atmosphere and a second calibration gas in the range between 10 and 100 ppm gaseous oxygen

OPTICAL OUTPUT / INPUT	
Optical connector	SMA compatible, 2 mm polymer optical fiber
Channels	1
Wavelength	505 nm

LCD Display	
Resolution	128 x 64 pixels
Background Illumination	green (LEDs) – function programmable
Contrast	Automatic contrast control

ENVIRONMENTAL CONDITIONS	
Operating temperature	0 to +50ºC
Storage temperature	-10 to +65ºC
Relative humidity:	up to 98% (NEMA 4)

DIMENSIONS	(D x W x H) 8” x 10” x 8” weight: 2,2 kg;

Analog Output and Input channels

4401 Oxy-trace v4 – instrument version is supplied with a four independent, programmable 12 bit analog I/O channels with galvanic isolation.

VOLTAGE OUTPUT

Channels	2
Pin Connection	Phoenix Connector Terminal Board
Resolution	± 2,5mV (12bit)
Programmable	Yes (oxygen, temperature, amplitude, phase)
Output range	0 - 10V (optional 0-5V) (Accuracy ± 10 mV)
Galvanic isolation	Yes
Update rate	same as digital data on RS232
Shortcut protection	Yes

CURRENT OUTPUT

Channels	2
Pin Connection	Phoenix Connector Terminal Board
Resolution	± 4μA (12bit)
Programmable	Yes (oxygen, temperature, amplitude, phase)
Output range	4 to 20mA (option 0-20mA) (Accuracy ± 5 μA)
Update rate	same as digital data on RS232
Galvanic isolation	Yes
Open-loop alarm	Yes

VOLTAGE INPUT

Channels	2
Pin Connection	Phoenix Connector Terminal Board
Resolution	± 2,5mV (12bit)
Programmable range	Yes (temperature, pressure)
Input range	0 to 10V
Programmable range	Temperature: 0-150°C Pressure: 500-2000hPa
Galvanic isolation	Yes

Note:

Current Outputs are Current Sinking

15.0 Technical Notes

POWER

4401 Oxy-trace is available in power from 80- 253 Vac or optional 9 – 24 Vdc. The 4401 Oxy can be powered by a external battery via connection directly to the terminal board. AC power is wired directly to the power supply mounted to the back plate .

ANALOG OUTPUTS

WARNING: The analog outputs are not protected against any input voltage! Any voltage applied to the analog outputs can cause irreversible damage of the circuit.

RS232 INTERFACE

The unit uses crossed interface cable. The use of other than the serial cable provided with the instrument can cause the unit's malfunction.

OPTICAL OUTPUT

The SMA connector is high precision optical component. Please keep it clean and dry. Always use the rubber cap to close the output when not in use.

WATERPROOF ENCLOSURE

4401 Oxy-trace v4 enclosure meets NEMA 4 standards. However Make sure that all cable plugs are installed in the enclosure cable grips if not used (Analog I/O). Care should be taken not allow water to ingress into the enclosure via the unused cable grips to cause device failure. 4401 Oxy-trace v4 has no internal dew fuse!

APPROVALS

The 4401 Oxy –trace NG has been approved for use in Hazardous locations by FM/CSA for Class I, Division 2, Groups A, B, C, and D

Operation Notes

OXYGEN MEASUREMENT

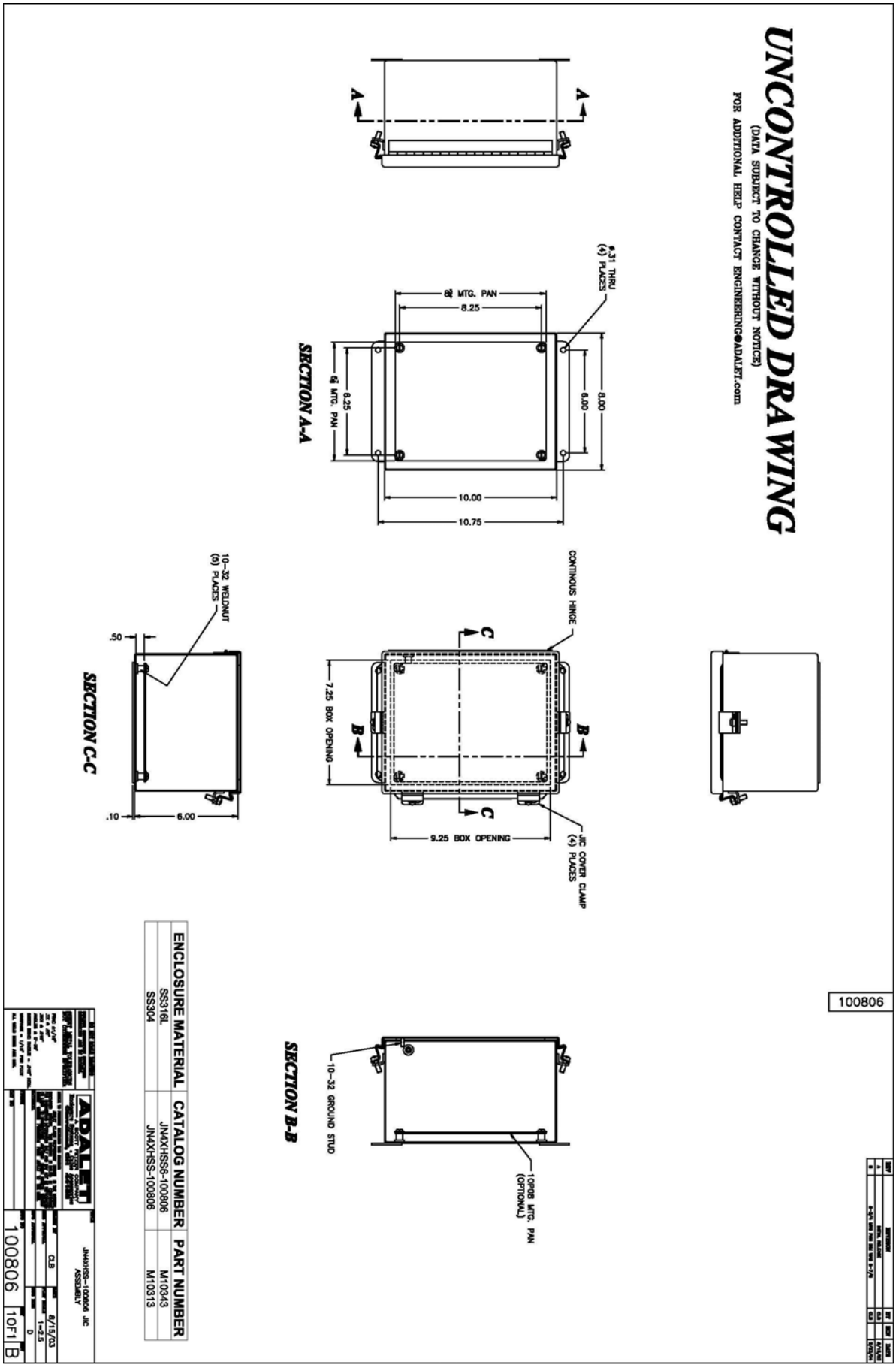
To achieve a highest accuracy 4401 Oxy-TRACE NG should be warmed-up for app. 5 min before taking a measurement. Please see the details of measurement process described in 4401 Oxy-trace v4 manual.

TEMPERATURE COMPENSATION

No other then supplied temperature sensor should be use with the unit. The use of any other temperature sensor can affect the oxygen compensation and can even damage the oxygen meter.

Support: www.BAT4pH.com

16.0 Enclosure Drawing



17.0 Parts List:

BOS 3 Trace Sensor	DP-BOS3-L5-ST5-NOP-SSJ
Power Supply (110 Vac)	B5400-1001
Board Set	B3600-0004
Calibration Span Gas	100 ppm balance Nitrogen
UHP Nitrogen Zero Gas	99.999% Nitrogen
Model 715 Regulator	1.5 LPM fixed flow
PT 1000 Temp. Sensor	RBJB0TA040KB150
4401 Calibration Test Mnl	Process Control Document
4401 TDS	Test Data Sheet for Calibration Test
RJ 11 Modular Cable	B3907-0026
RJ 22 Modular Cable	B3907-0027
Ribbon Cable	B3907-0028
Cable Grip	B4954-0156
Terminal Board, Phoenix	B3304-0007
Enclosure (10x8x6) 316	B5023-0010

Trouble Shooting Guide

Indication	Cause	Solution
No Sensor Detected	Fiber Optic Cable Not Connected	Make sure that the SMA connector is connected properly to the connector
No Sensor Detected	Oxygen Sensor Damaged	Check the amplitude (signal) of the Sensor, it must be above 1500. Check flow to make sure the line is not plugged preventing the sample to the sensor.
Oxygen readings incorrect	Incorrect Sensor Selected	Check to make sure you have the proper sensor selected: BOS 1; 0 – 4.2%; BOS 2; 0 – 50%: BOS 3; 0 – 1000 ppm
Oxygen reading unstable	Oxygen Sensor	Check for Low Amplitude (signal) to make sure it is >1500, check for low flow or unstable flow on sensor.
Temp Sensor Not Detected	PT 1000 Sensor	Check to make sure that you have a temperature sensor connected.
Out of Range	Oxygen Sensor	Sensor flow is blocked, clear sample line and reset flow to 1.5 lpm
Phase Value too low	Oxygen Sensor out of range	Check for blockage on sample line and reset flow to 1.5 lpm.
Unable to read Oxygen	Current Loop Open	Connect current loop to recording or monitoring device.

19.0 Error Codes:

bit 0 = ADC overflow
bit 1 = Ambient light
bit 2 = no oxygen sensor
bit 3 = no temperature sensor
bit 4 = current output 1 open loop error
bit 5 = current output 2 open loop error
bit 6 = overheat
bit 7 = system restart

Decoding example

If Error value received from a device is **10** then a following error has occurred:

Decimal **10** = Binary **00001010**

Here bit1 ⇔ ambient light and bit3 ⇔ no temperature sensor are “1”. This error code would appear if there was too much of ambient light (sun light illuminating the sensor) and the temperature sensor PT1000 is not connected to the device.

Binary Table

0001 = 1	0110 = 6	1011 = 11
0010 = 2	0111 = 7	1100 = 12
0011 = 3	1000 = 8	1101 = 13
0100 = 4	1001 = 9	1110 = 14
0101 = 5	**1010 = 10**	1111 = 15